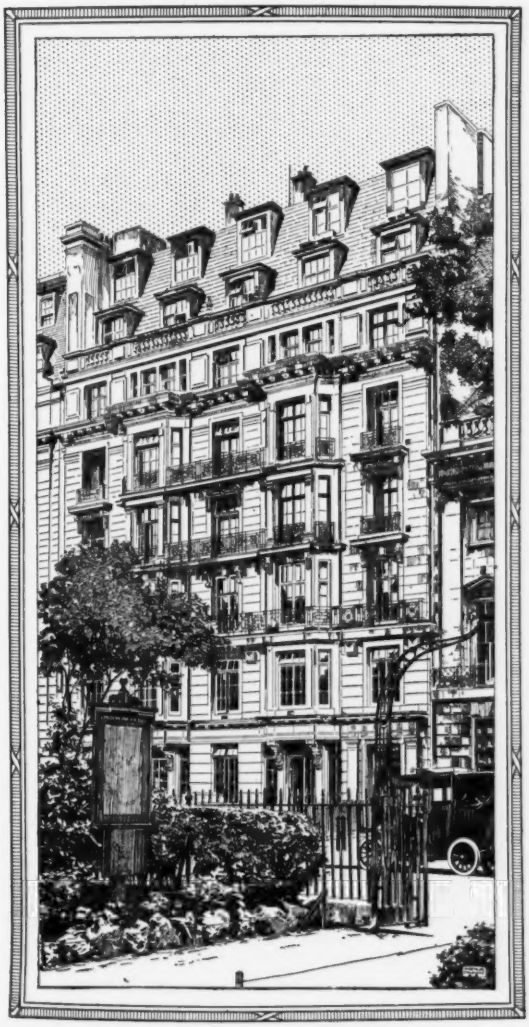
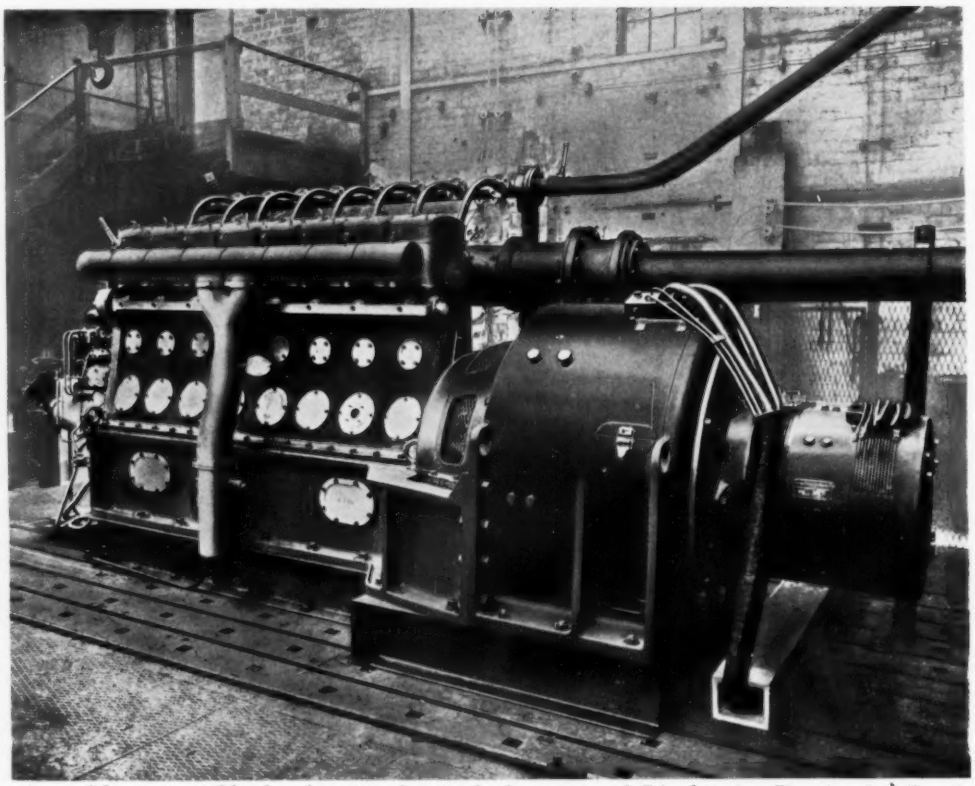
The ENGLISH ELECTRIC JOURNAL



Queen's House from Lincoln's Inn Fields.

All rights of republication, including translation of articles, are reserved.

Diesel-Electric Traction on L M S Railway.



An article on page 80, drawing attention to the importance of Diesel-electric Traction describes the equipment illustrated above. The train is equipped with the 500 H.P. Diesel-electric unit shown on the test bed in the lower view.

The English Electric Journal

Vol. IV. No. 3 APRIL, 1928 One Shilling.

CONTENTS.

	PAGE
Electrical Equipment of P.O. (London) Railway	64
Electrification of La Guaira & Caracas Railway	74
Shunting Locomotives for the Bombay, Baroda & Central India Railway	77
Diesel-Electric Traction	80
Electrification of Capetown Suburban Railways	86

All Communications respecting Editorial Contents should be addressed to The Editor, The English Electric Journal, Queen's House, Kingsway, London, W.C.2.

EDITORIAL.

Of the articles in this number referring to Electric Traction contracts executed by this Company on the four continents, two, describing important developments in diverse phases of transport engineering, serve to emphasise the unique advantages obtainable by using electricity for traction purposes.

The conception of a tube railway to be used solely for transporting mails across London could hardly have materialised had it not embraced the principle of automatic and, therefore, of electric operation. Consequently, it is to electric traction that we owe the speedier and more economic forwarding of our mails, and, as a corollary, a reduction in the vehicles on the streets. It can scarcely be doubted that the Post Office (London) Railway will prove the forerunner of similar schemes in other capital cities.

Diesel-electric traction is the latest example of the striving to utilise for self-contained traction units, a more economical type of prime-mover installation than the ordinary steam engine. The application of the Diesel type of engine for this purpose is rendered simpler and more efficient by wedding it to electricity as the transmitting and propelling agent, and there is every prospect that the system will be widely employed for special classes of traffic where full electrification is not yet commercially practicable.

MAJOR H. GUNTON, M.B.E., M.I.E.E., M.INST.T.

MR. A. M. SILLAR, M.INST.C.E., M.I.E.E., M.I.MECH.E.

The construction of the Post Office Railway, the electric equipment of which is described below, was carried out under the direction of the Post Office Engineering Department. The work was supervised by the Principal Power Engineer, Major H. Gunton, on behalf of the Engineer-in-Chief, Colonel T. F. Purves, M.I.E.E. The Consulting Electrical Engineer in the earlier stages was Sir John Snell, who on his appointment to the Electricity Commission, was succeeded by Mr A. M. Sillar. [*Photographs by Elliott & Fry*]

The Electrical Equipment of the Post Office (London) Automatic Railway.

The recent successful inauguration of the service of trains on the P.O. (London) Railway marked the completion of a unique undertaking that has attracted wide interest.

As is well known from articles published in the daily and technical press, this railway, which carries mails between the General Post Office, two main line railway termini and various district post offices, is automatic in operation. It is this feature which differentiates it from any other traction scheme in existence.

The history of this contract is one of continuous study and experiment in the adaptation of electrical and mechanical appliances to overcome the particular problems of automatic operation, which in large measure were problems arising from varying atmospheric conditions.

Initiated in 1914 with an experimental wagon built by Dick, Kerr & Co., and tested at Woolwich by the G.P.O. engineers, the scheme was suspended during the war and revived when normal industrial conditions were re-established. After consideration of many suggested systems, it was finally decided to instal the simplest possible form of D.C. traction, and this choice has been fully justified by the results.

The comprehensive contract for the complete electrification of the line awarded to The English Electric Company, embraced the supply of substation equipment, high-tension and low-tension cabling, rolling stock, control and signalling apparatus, third rail, ventilating plant and tunnel lighting, as well as the electrical equipment for operating the wagons in the depôt. The work was put in hand in 1925, the tunnel and running rails then being practically completed.

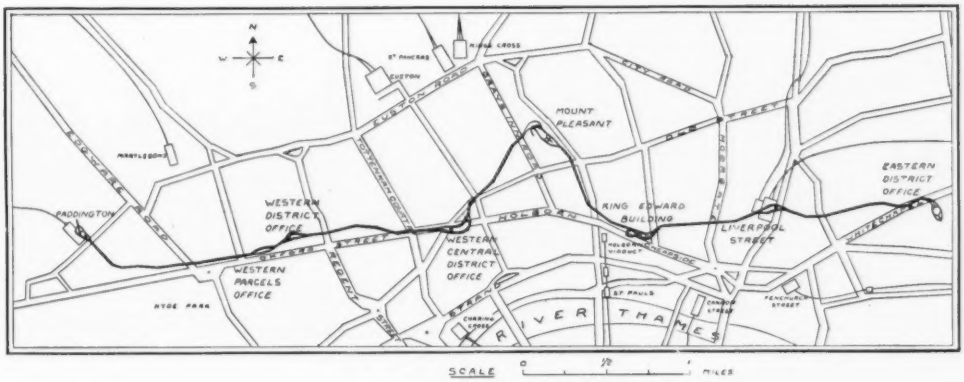


FIG. 1. PLAN OF THE LINE.

A plan of the line, which is approximately 6½ miles long, is shown in Fig. 1. Every station is provided with several berths on each side of the island platform and with a through line in each direction; certain stations are provided with loop lines and dead end sidings. At Mount Pleasant there is a wagon storage and repair depôt, connected by a double track of 1 in 20 grade to the main line. As the depôt itself is below ground the whole of the material and electrical equipment had to be lowered down a shaft to the depôt and then transported to the desired point on trucks. Fig. 2 is a view taken at the shaft head during the lowering of a bedplate.

FIG. 2. SHAFT AT MOUNT PLEASANT, DOWN WHICH ALL MATERIAL HAD TO BE LOWERED.

Before describing the various sections of the plant in detail, an outline of the system of operation will first be given.

Electric power is delivered to the sub-stations as a 6,600-volt, 3-phase, 50-cycle supply and is converted to direct-current at 440 volts. An auxiliary low-tension direct-current supply at 150/160 volts is provided at each station by means of motor-generators.

The third rail is divided into sections, each of which is separately energised through a contactor. Generally speaking, the sections of third rail in the tunnel are energised at 440 volts, and those in the stations at 150 volts.

The whole of the train movements are controlled in each station through levers on a control desk, similar to those used on railway power signalling systems. To despatch a train from a station the operator moves the requisite lever, thereby closing an electrical circuit which in turn closes the contactor supplying current to the section on which the train is standing. The train moves forward and passes from section to section, these sections being automatic-

ally energised, but interlocked so that a train in passing renders dead the section behind it. At the approach to each station is a braking or dead section on which the train first comes to a standstill and then starts again automatically. In this way the train enters the station at a moderate speed and is finally brought to rest on another dead section at the station platform.

The electric wagons are provided with powerful brakes, which are held off the wheels when current is passing through the motors.

It will be obvious that while this operation is very simple in principle it implies absolute uniformity in the performances of all trains, very close adjustment of the length of the sections, and careful experiment in every case to establish the exact relations between grade, track curvature, speed of train, supply voltage and the stopping point.

The trains attain a speed of 35 miles an hour between stations, and to ensure an efficient time table the maximum possible acceleration and deceleration are necessary. At the same time every train, under all possible variations of track conditions, load and voltage, must stop within plus or minus 6 ft. of a given point on the station platform.

The following is a brief description of the plant and apparatus installed to achieve the desired results:—

SUBSTATIONS. — There are three substations, each equipped with two 400 kW. rotary convertors, either of which is sufficient to supply the power required, leaving the other as a spare. The rotary convertors are supplied from banks of single-phase oil-immersed, self-cooled transformers and are of standard "English Electric" type provided with pony motors for starting. In order to ensure the lowest possible voltage variation, regulators have been installed of the Taylor-Scotson type, supplied by Messrs. Cox-Walker, Ltd. These regulators are called upon to maintain constant voltage when loads varying from practically no load up to 25 per cent. overload are suddenly thrown on the convertors, a negative boost of approximately 200 volts on the converter fields being converted almost instantaneously into a positive boost of equal amount. This may take place several times an hour, and it is probably one of the heaviest duties which any regulator is called upon to perform.

The high-tension and low-tension switchboards are also of standard "English Electric" design. The supply from the 440-volt busbars is taken through a busbar on a rack on which are mounted the contactors of the Company's standard traction type for energising the track sections.

For furnishing the 150-volt supply, every station is provided with two motor-generators, each of 30 kW. or 20 kW., according to the size of the station, fed from the 440-volt mains. The supply from the 150-volt switchboard busbars is also taken to the contactor racks mentioned and is there connected to the 150-volt contactors.

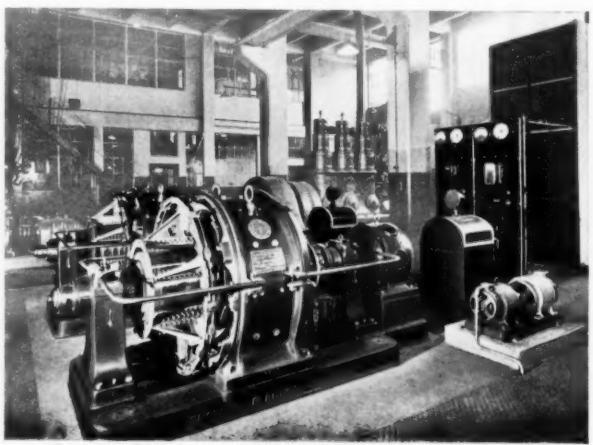


FIG. 3. SUBSTATION EQUIPMENT AT MOUNT PLEASANT.

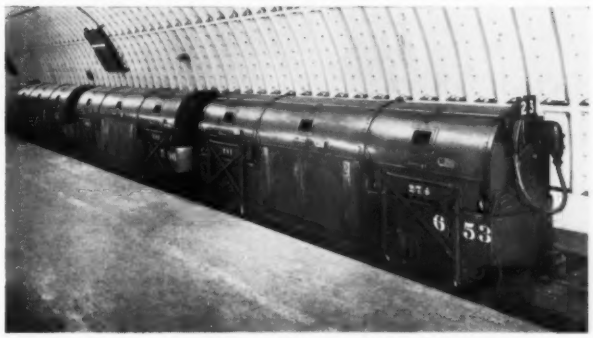


FIG. 4. A NORMAL TRAIN OF THREE WAGONS.

Fig. 3 illustrates the substation at Mount Pleasant which is installed in an existing building above ground. The other substations are built in the lower portion of the station segments below the platforms and running rails.

Various auxiliary services in each station are also supplied from the 440-volt supply, and these are controlled from switchboards situated in the substation.

ROLLING STOCK.—A total of ninety motor wagons has been built, and these are made up into thirty trains of three wagons each. Each wagon is equipped with two 22 H.P. series traction motors driving through single-reduction spur gearing. Current is collected by two collector shoes on each wagon which are connected through resistances to a bus-line cable running from end to end of the wagon and terminating at a plug and coupler at each end, so that in a three-car train there is a bus-line fed from six collector shoes. Each motor is fed direct from the bus-line.

The two motors of each wagon have their field coil terminals brought to a hand-operated reverser. The brake blocks on each wheel are Ferodo-lined, and are applied by means of a nest of springs, counteracted by a powerful solenoid connected in series with the traction motors. Hence the brakes are held off the wheels whenever current is passing through the motors, and are applied on a current failure or when the train reaches a dead section. Means have to be provided, however, for moving the wagons in cases of emergency, with no current in the solenoid, and therefore the brakes can be screwed off the wheels by means of a hand-wheel situated at the same end of the wagon as the reverser and interlocked with it. This interlock is mechanical, and is so arranged that the brake can only be screwed off when the reverser is in the " off " position, and the reverser can only be set to " forward " or " reverse " when the brakes are free to operate automatically. Fig. 4 illustrates a normal train, and others appear in several of the accompanying views.

The wagons are of sheet steel on a channel frame with cast-steel axle-box guides; the axle boxes are of malleable iron and are fitted with roller bearings. Each vehicle is 13 ft. 6 in.,

By Courtesy of "The Times."

FIG. 5. MAILS IN STANDARD CONTAINERS BEING LOADED ON A TRAIN.

over buffers and 12 ft. over the body, which is divided into three portions. The centre portion has its floor approximately level with the station platform, while the two end portions are of such dimensions as to house beneath them the motors and electrical equipment. Each compartment is enclosed by semi-circular covers, those in the centre retaining in position the side flaps which, as will be seen in Fig. 5 (illustrating a train being loaded at a station) let down to form a runway for the mail containers. The mail is loaded in the containers, and the containers fit closely into their compartments.

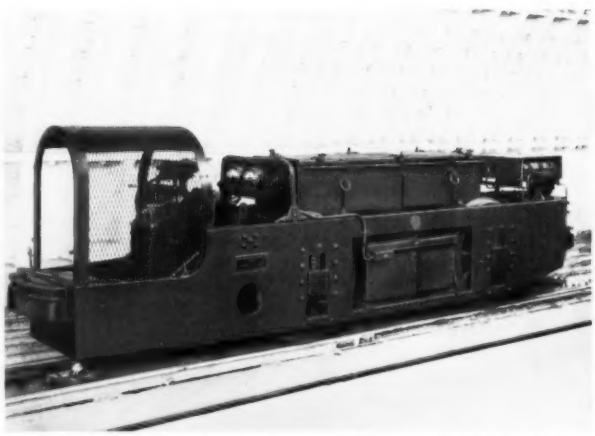


FIG. 6. BATTERY LOCOMOTIVE FOR EMERGENCY SERVICE.

The arrangement described above enables a train to start from rest with a direct application of 440 volts, which gives it an initial acceleration of 3 m.p.h. per second. On level tangent track the trains attain a speed of 30 m.p.h. The brakes are set to give the utmost possible retardation, i.e., something just under the skidding point of the wheels. It has been found in practice that a train can run with safety a minimum distance of 400 miles without adjustment to the brakes.

BATTERY LOCOMOTIVES. — Three battery locomotives are provided for use in case of emergency. They are 16 ft. 6 in. long and 3 ft. 5 in. wide by 4 ft. 11 in. high and have a working weight of 7 tons. On test these locomotives were capable of starting six loaded wagons, equivalent to 18 tons, on a 1 in 20 grade, and in service they have hauled up to 54 tons (equivalent to six loaded trains) at 16 m.p.h. The electrical equipment consists of two 25-H.P., 350-volt totally-enclosed motors operated by a controller with four series, three parallel and five braking notches. In addition to the rheostatic brake there is a hand brake of the screw down type operating shoes on all four wheels.

The " D.P." battery consists of 163 cells in two removable containers, and is rated at 84 ampere-hours at the 5-hour rate of discharge. Fig. 6 illustrates one of these locomotives.

POWER DISTRIBUTION.—For the service of the extensive buildings at those points, large substations already existed at Mount Pleasant and the G.P.O., and the main 6600-volt supply for the railway is, therefore, distributed from these substations to the new traction substations at Paddington and Liverpool Street respectively. As already mentioned the railway substation plant at Mount Pleasant is installed in the general substation building. There is a 6600-volt interconnecter between Mount Pleasant and G.P.O. and all E.H.T. cables are run in duplicate.

The three traction substations furnish the 440-volt, direct-current supply to the conductor rails in their respective areas.

In view of the continuous track-circuit system monopolising one rail of each track, the track return has been augmented by laying two 1 sq. in. bare copper cables, cross bonded to the double track every 100 yards.

CONDUCTOR RAIL.—A 15 lb. per yard channel type rail is used, located in the centre of the track 3 ins. above the face of the track level. Each joint is double bonded, by 14-in. long 4/0 SWG. flexible bonds with solid ter-

minals. The conductor rail is supported on porcelain insulators spaced 9 ft. apart, and the ends of each length are anchored to the sleepers as a precaution against creeping, especially in the case of short lengths employed at special trackwork. For sectionalising the conductor rail a 10-in. fibre block spacing piece is inserted between the ends and held in place by long fibre fishplates.

CONTROL OF TRAIN OPERATION.—The track is divided into a number of sections, that is to say, the third rail is divided into sections insulated from each other, and one running rail of each track is similarly divided. The supply to each section of third rail is, as previously mentioned, obtained through an electro-magnetic contactor, and the operating coil of each contactor is controlled conjointly by automatic relays and the operator's signal lever desk in each station.

Each stretch of track between adjacent stations is divided into three running sections and one braking section, and the control of these sections is entirely automatic. The station lines are divided up into sections, the number of which depends on local circumstances and the number of berths at the station platforms. Movement of trains in the station sections is semi-automatic, being controlled by the station operator, but under automatic safety control.

The system employed is known as the Ferreira-Insell Route Lever System.

Each station is constructed with an island platform, an up and a down through track and an up and a down station track, the latter being divided into from one to four berths. All station operations are controlled from a control cabin situated between the two platforms and equipped with a control lever desk and an illuminated track indicator. Housed in the switchroom or substation below the platform are the contactors, the relay cabinets, and the batteries for the track circuits.

The system is protected by continuous track circuiting with track relays operated at 24 volts from batteries. The presence of a train on any section of the line completes the track circuit and causes the track relay for that section to pick up. Each track relay works in conjunction with a "stick" or repeater relay which is normally energised through one of the contacts of the track relay and one of its own contacts. When the track relay picks up it de-energises the stick relay, which therefore drops. When the track relay drops owing to the train leaving the section, the stick relay will not pick up as the supply from the track relay through its own contact was broken when it fell away. It is given a " reset " feed to pick it up, from the track relay next down the line when the latter picks up. This ensures that if a train runs into a section without occupying it, the section behind it will still be blocked.

FIG. 7. AN OPERATOR'S CABIN SHOWING THE CONTROL LEVER DESK.

A control lever desk is illustrated in Fig. 7. Each lever is operated with a horizontal movement into any one of six positions, but no lever can be pulled to its full extent in one motion, as it is twice checked by means of a

relay operating a lock which engages with the slide on the lever. The first position is the " on " or normal position. The first check is on the second position; this sets up a circuit through all the track circuit relays of the route desired " clear," through the No. 2 contacts on the lever to the check lock relay. If all the tracks ahead are clear, the lock is released and the lever can be pulled to the fourth position. This energises the contactors which supply the point motors. When the points have thrown, a circuit is completed through the point blade detectors to No. 4 contacts on the lever to the check lock relay, and the lock is released allowing the lever to be pulled right out to the 6th position, which energises the power contactors of the route concerned.

The checks on the backward movement of the lever are at the 5th and 3rd positions; the 5th is the track lock and the 3rd the points lock. This is necessary since a train must complete the route before any points are reset to normal; therefore, No. 5 proves the track clear first, and then No. 3 restores the points to normal. The lever can always be put back from No. 6 to No. 5 so as to cut power off the

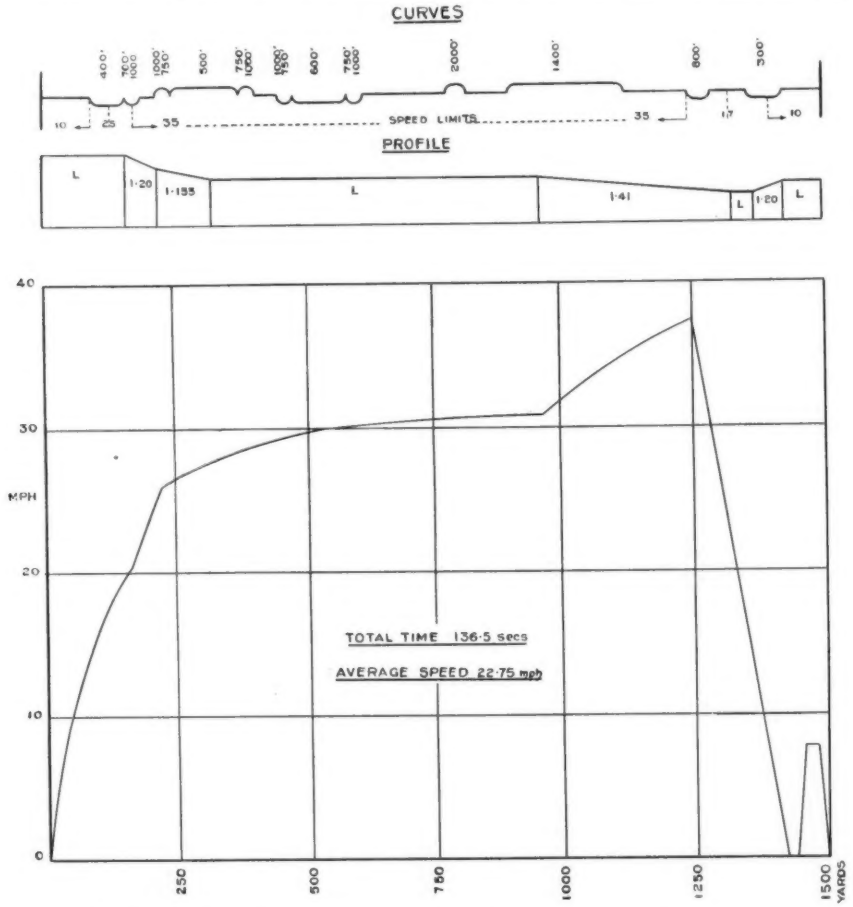


FIG. 8. A STATION TO STATION STRETCH. CURVES, GRADIENTS & SPEEDS.

line in order to stop a train in case of emergency.

For emergency operation all sections on one road, including the automatic sections controlled by the station concerned, are cut dead if a lever called the King lever is pulled. This also frees the track locks of all levers on that road, allowing points to be thrown for emergency or maintenance working.

So far we have described the operation of the three automatic sections between stations, and the operation for the reception and despatch of trains in the stations. There remains the operation of the braking section.

As has been previously pointed out, the trains have to be brought down from a high speed in the tunnel to a speed of about 7 miles per hour on the receiving section at the station approaches. To reduce the speed the train enters a " dead " or braking section which also includes a 1 in 20 up grade, and to ensure absolute uniformity of speed on the receiving section, the train is brought to a dead stop on the braking section first. It is then energised for a definite period at 440 volts, and then runs at 150 volts on to the 150-volt receiving section. The performance of the train on this part of the line will be clearly noted from the speed-distance curve in Fig. 8.

The operation of the train on the braking section is automatically controlled by an " English Electric " camshaft controller. As is well known, this type of controller consists of a set of cam-operated contactors, the camshaft being driven by a motor controlled through a contactor, a drum-type switch known as the position regulator, and a hand-operated master controller. On an automatic railway of the kind now described the train itself and the track relays fulfil the function of the master controller and the cam-operating motor the function of a time limit. A station group of braking and shunting camshaft controllers is shown in Fig. 9.

When the train enters the braking section, which is dead, the brakes are automatically applied. At the same time the presence of the train lifts the track circuit relay and a connection is set up which initiates the rotation of the camshaft. The train comes to rest, and after a definite interval from the moment the train has entered the section, the rotation of the camshaft closes a contractor which applies 440 volts to the third rail. The actual time delay between the stopping and starting of the train is very small, the setting having been found by experiment in each stations under every combination of atmospheric, load and emergency conditions.

After 440 volts has been applied for a few seconds, the further rotation of the camshaft changes the supply to 150 volts, and this supply is maintained until the train leaves the section. The camshaft then proceeds to rotate to the " off " position. The crossover section which follows the braking section is also energised at 150 volts and the train proceeds at a low speed until it reaches one or other of the station sections which are normally dead, and at which the train comes to rest.

SIDINGS.—Shunting into and out of sidings is automatic. The only part of the operation done by hand is reversing the train once it is in the siding. The automatic operation is effected by a camshaft controller in a similar manner to that described above for the main line.

The sidings, with one exception, are single line and have a series of berths. They are entered from one road and left by another in the form of a " Y," and the points which connect the entry and exit roads are automatic. With a view to getting as many trains as possible into a siding, the berths are made as short as possible, and consequently the speed has to be kept low. It is arranged that any train entering the siding shunts down to the last unoccupied berth, and to keep the speed low a halt is made on every berth that is passed through. The camshaft again acts as a time lag, notching up under the control of the train, and energising the berth on which the train is standing a few seconds after it has come to rest.

As mentioned earlier, the points in the sidings are completely automatic, and are operated by the position of the trains themselves. In Mount Pleasant siding, which is a twin road approached through a single line bottle neck, there are two sets of points, both of which are automatic. It is believed that these are the only automatic points of the kind in Great Britain other than those recently installed on the Mersey Railway.

The control of trains down the 1 in 20 grade from the Car Depôt at Mount Pleasant to the main line is effected in a manner similar to the movements in the sidings. The line is sectioned and the train brought to rest at intervals so as to limit the speed, and ensure that entry into the station is made at an easily controlled speed.

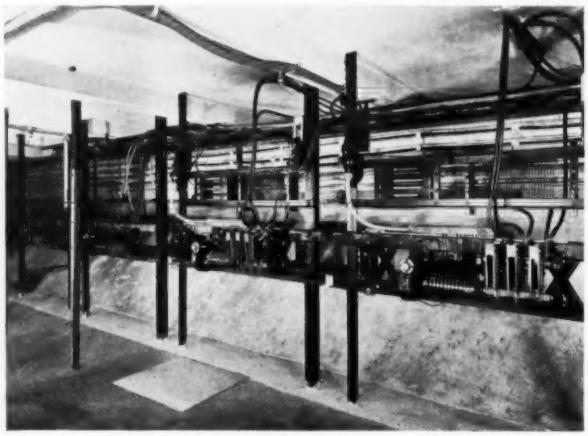


FIG. 9. A STATION GROUP OF CAMSHAFT CONTROLLERS.

In every station there is an illuminated diagram which indicates to the switchman the position of all trains in the station, and on the automatic sections at either side of the station. The destination of trains is indicated by a " Send and Receive " board situated in the control cabin of each station. This is simply a panel with a series of pilot lights and plungers, each alongside a strip on which is painted the name of a station or group of stations. When a train is about to be despatched the switchman presses the plunger against the group of stations where the train is scheduled to stop, say, KEB.-L'st.-EDO. This lights up a white pilot light against this strip in his cabin and also alongside the corresponding panel in the next station. In addition it also lights up a red light alongside the " Receive Next Eastbound " strip at the next station. When the train arrives the switchman pushes the plunger against this strip, and the three lights are extinguished. These lights and plungers are duplicated, one set on each side of the name strip, so that two trains can be indicated at once. The only difference is that when the second train is described the red light does not come up against the " Receive Next Eastbound." When the first train is cancelled out, the red light automatically transfers itself to the second indication. Illuminated indicators are placed opposite each platform berth to inform the platform staff of the destination of the trains. These are simply worked by jack plugs from the cabin.

Catenary wires or plunger switches are provided on the platform, and when a train has finished loading, and is ready for despatch, the platform staff is able by this means to complete a circuit to a red light on the platform indicator and a green light in the signal cabin. These lights are cancelled by a plunger operated from the switch cabin after the train has left.

CAR DEPOT.—Third rail operation in the Car Depôt was considered inadvisable and current to manœuvre the trains is therefore taken from a double overhead trolley wire system by means of four-wheeled trolleys running on a steel " I " beam suspended from the roof, with a flexible cable and plug for connection to the wagon.

The control of the trains is from a central control point on an elevated platform. Three hand-operated controls are provided, each controlling one track through a contactor and resistances. The resistances are so graded that in conjunction with the controllers, single-wagon, two-wagon or three-wagon trains can be adequately controlled. The flexible connections to the trolley are fitted with push button switches, so that when operating at a distance from the control position a shunter can open a contactor on the control platform and stop the train. Fig. 10 gives a general view of the car depôt.

VENTILATION.—A complete system of ventilation has been installed at each station, and in order to provide efficient ventilation for the machinery under the station platforms the fresh air is delivered through ducts just below the floor of the basement. From these ducts the air is so distributed as to give the necessary circulation round the plant and batteries. Air is extracted by separate circular iron ducts supported from the top of the station roofs and the discharge is taken up one of the shafts. To avoid any possible draught up the shafts or stairways the volume of air extracted is in excess of the delivery.

The following are a few interesting statistics relating to this railway:—

It is in operation 21 hours out of each 24, for 6 days a week. 53,000 car-miles per week are being run at present on less than full service.

The average speed is 17 miles per hour.

The overall speed, including time for loading, unloading, and standing by during idle periods, is 5.5 miles per hour.

3,576,000 ton-miles were run between December 13th, 1927, and March 8th, 1928 (87 working days).

3,960 H.P. installed on rolling stock.

2,400 kW. plant in the substations.

45 miles of power cabling were used.

77 miles of signal and control cabling were used.

Total number of relays 1,047, making 6,351 double contacts.

As main contractors for the equipment described in this article, The English Electric Company manufactured and installed the electric wagons, battery locomotives, rotary convertors, H.T. and L.T. switchgear, transformers, feeder contactors, camshaft controllers and car depôt control. Amongst the principal sub-contractors for other portions of the work, mention may be made of Siemens Brothers, Ltd., who were responsible for the control and signal cable; Siemens & General Electric Signal Company who supplied the signal apparatus, point motors, track relays and relay cabinets; R. W. Blackwell & Co., and British Insulated and Helsby Cables, sub-contractors for the track work and power cables respectively, and the D.P. Battery Co.

In conclusion, grateful acknowledgment for permission to publish this description is made to the Post Office Engineering Department, whose work, in conjunction with that of the Consulting Engineer, Mr. A. M. Sillar, contributed so largely to the successful issue of the undertaking.

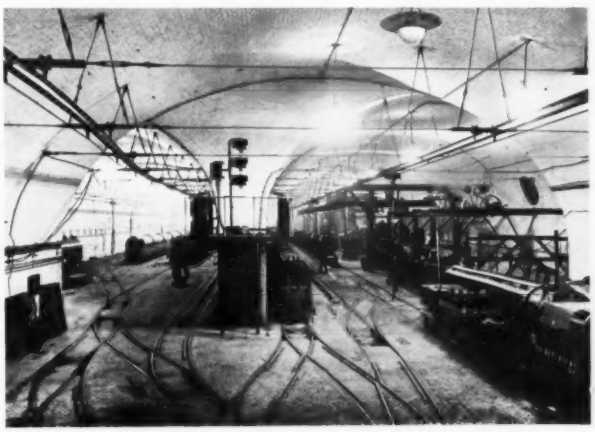


FIG. 10. GENERAL VIEW OF CAR DEPOT.

Electrification of La Guaira & Caracas Rly.

The La Guaira & Caracas Railway is a 3-ft. gauge mountain railway in Venezuela, connecting the town of Caracas situated 915 metres above sea level with the port of La Guaira. Although the distance between these two towns, as the crow flies, is less than 12 km., the difficult nature of the country has necessitated an actual length of track of 36.5 km., the average radius of curvature over 75 per cent. of the line being 60 metres. Severe grades up to 3.7 per cent. are encountered and there are no intermediate halts between the two termini.

To supply the track a power station has been erected at Zig Zag, about half-way between the two towns. Power is supplied from this to an overhead line, the busbar voltage being 1650 and the minimum line voltage 1,250. Under these conditions the single journey in either direction is performed in 1 hour 12 minutes by the motor coaches, each of which weighs 27½ tons and carries 44 passengers and 3 tons of baggage, besides hauling a passenger trailer weighing 12 tons in all.

THE POWER STATION.—The equipment supplied by The English Electric Company consists of three slow-speed traction generators driven by Diesel engines (supplied under another contract) and a switchboard.

The generators operate in parallel on the 1500/1650-volt traction line, the full 1650 volts being generated on a single commutator. The load fluctuation is very great, the current changing rapidly from 10 per cent. to 130 per cent. of full load at frequent intervals. These conditions have been successfully met by special features in the design and the commutation under service conditions is sparkless.

The full-load output of each generator is 425 kW. at 200 r.p.m., with an overload capacity of 25 per cent. for 2 hours and 100 per cent. for 1 minute. The general construction is shown in Fig. 2. The armature is wound

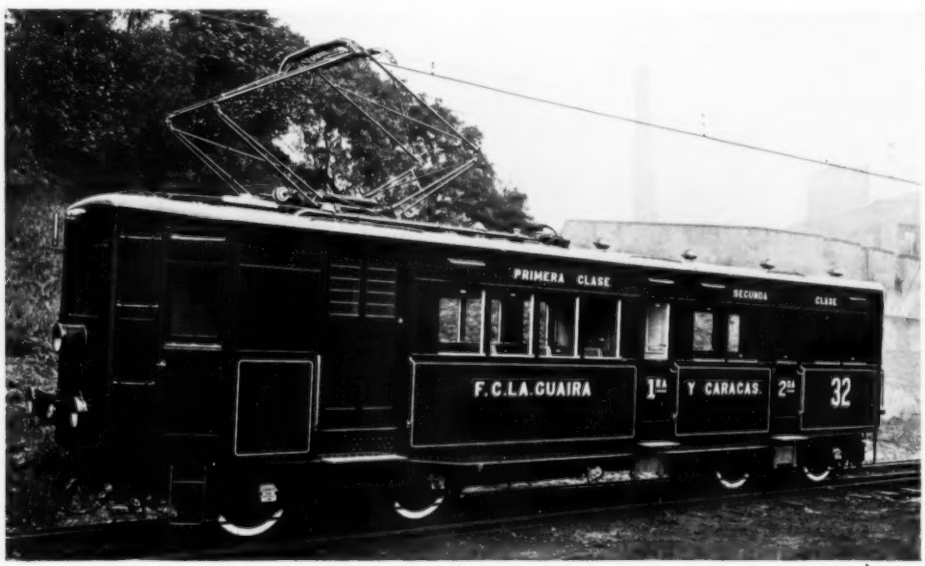


FIG. 1. ONE OF THE PASSENGER COACHES ON THE TEST TRACK AT PRESTON.

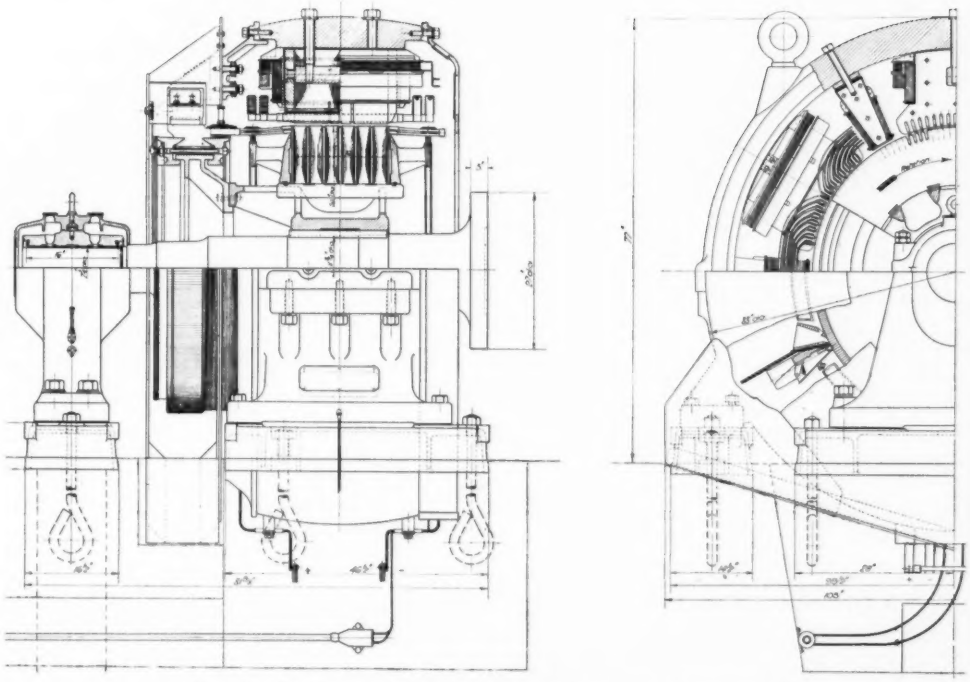


FIG. 2. GENERAL ARRANGEMENT OF THE 1650-VOLT GENERATORS.

with a 6-pole two-circuit wave winding with a large number of commutator segments sufficient to secure the use of single-turn armature coils. The insulation of the armature winding is mica pressed solid on the armature coils and arranged to provide long creeping surfaces to earth. The winding is laid in slots skewed to the axis of the machine in such a manner as to eliminate magnetic ripples in the commutation zone.

In order to accommodate the large number of commutator segments necessitated by the high voltage and low speed, and at the same time to keep the brush arms well apart from each other, the commutator is made the same diameter as the armature. The commutator is constructed on the non-archbound principle, each segment being held independently of its neighbours, between mica-insulated " V " rings.

The protection of the machine against flash over from brush arm to brush arm or from brush arm to body is secured by flash barriers which shroud the commutator surface at each end and underneath. Two fans, one on the armature surface which acts axially and the other on the commutator end which acts radially, and porcelain arc chutes of special form on the brush gear, disperse the ionized air clear of the machine.

The field magnets are of steel, the main poles being compound wound for a level characteristic at the mean voltage. The shunt coils are self-excited at 1500/1650 volts. A compensating winding is as usual located in slots in the main pole face.

The switchboard, shown in Fig. 3, is constructed on the " dead front " principle, i.e., no H.T. metal is accessible from the front of the board; the H.T. apparatus, connections,

etc., are mounted behind the board sufficiently high to be out of ordinary reach.

The circuit breakers and isolating switches are operated by standard handles from the front of the board.

The instruments are of standard pattern, but are mounted on insulators behind and clear of the switch panels, the latter being cut away and fitted with windows through which the instrument dials can be seen. It will be noticed that knife switches and an apparently unprotected recording ammeter are mounted on the lower panels. These, however, are connected in the negative side so that they are at earth potential. The illustration shows the 1650-volt D.C. switchboard supplied for operating three generators and three feeders.

A high-speed circuit-breaker is installed with each generator. The control switch and indicating lamps for these can be seen at the bottom of the upper panels controlling the machines on the left of the board.

MOTOR COACHES.—The motor coaches, one of which is illustrated in Fig. 1, were built by Messrs. Craven's Railway Carriage & Wagon Co., Ltd., of Sheffield. They are of all-steel construction, and have a length over pillars of 44 ft., the distance between bogie centres being 26 ft. 6 inches. They are divided into a driver's cab at either end, a high tension compartment for the electrical gear adjacent to one of the driver's cabs, a luggage compartment, and 1st and 2nd class passenger compartments.

The bogies are built of steel plates and angle irons and have a wheel base of 7 ft. Two inward slung D.K. 109 traction motors are mounted on each bogie, and these transmit the drive to the wheels through spur gearing. The motors, which have roller armature bearings, develop 66 H.P. each at 750 volts, on the one-hour rating, and are self-ventilating. They are arranged in pairs in permanent series.

To facilitate negotiation of the sharp curves a Hasler Flange Lubricator is fitted to one pair of wheels on each bogie.

The nature of this line demands absolute reliability of the brakes, and thus three independent brakes are fitted—straight air brake, hand brake, and electric brake. For electric braking each pair of motors is connected in series with its own main starting resistance and an extra section of resistance used only for braking. Four braking notches are provided and the spacing of these has been chosen so as to correspond as nearly as possible to the requirements of the safe speed on the various grades. On the down run the electric brake is in almost continuous use, and the air brake is used only at infrequent intervals and for bringing the train to rest.

The control gear for the motors is standard "English Electric" camshaft control with 6 series, and 5 parallel notches, together with the 4 braking notches mentioned above. All power notching is carried out on the camshaft, and the braking is effected by solenoid-operated contactors. A 2 kW. motor-generator set mounted under the car supplies the control circuits and lighting at 100 volts. This motor-generator is provided with a voltage regulator which keeps the control and lighting voltage constant to within plus or minus 1 per cent., with a line variation of 1300

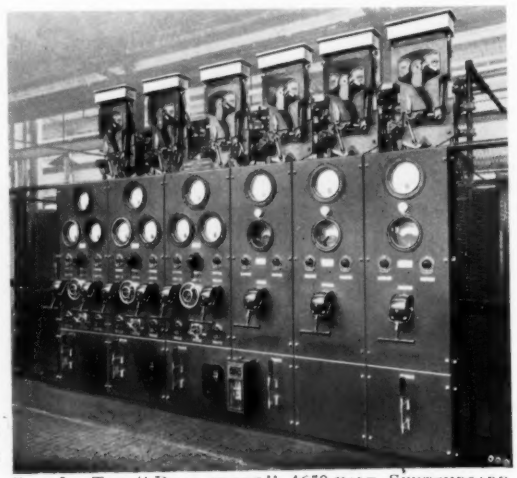


FIG. 3. THE "DEAD-FRONT" 1650-VOLT SWITCHBOARD.

volts to 1650 volts. A " D.P." battery consisting of 40 cells of 36 ampere-hours capacity is also used. In normal operation this battery energises all the control circuits for the electric brake, so that the electric brake remains operative, even if the main 1500-volt supply should fail. For emergency operation, by means of a hand switch, the power control and lighting may also be obtained from the battery.

The control is arranged for multiple-unit operation. All the control gear is mounted in the high-tension compartment, with the exception of the battery which is in the luggage compartment, and the motor-generator set, resistances, and compressor, which are slung from the underframe of the car.

The coaches are designed to have a free running speed of 45 km.p.h. on level track and to negotiate the maximum grade of 3.7 per cent. at a speed of 29 km.p.h.

Four motor coaches were supplied, and each of these was completely erected and tested on the Test Track at Preston Works before shipment. The coaches are now at Caracas, but have not so far been in operation, owing to unforeseen delays to the opening of the electrification.

Shunting Locomotives for the Bombay, Baroda and Central India Railway.

There have recently been completed at Preston Works two large battery shunting locomotives for the Bombay, Baroda & Central India Railway Company, which are of considerable interest.

These locomotives are the largest battery locomotives built in England, and are to be used for shunting in Carnac Bridge Yard, through which is handled practically the whole of the produce brought into Bombay by this Company's lines.

As will be seen from Fig. 2, the locomotives are of the double-bogie central-cab type with the batteries mounted in the two end compartments. The locomotives weigh 50 tons each, and are fitted with four 60 H.P. motors.

The normal battery voltage is 440, and at the continuous rating of the motors the locomotives give a tractive effort at the tread of the wheels of 7,600 lbs. at a speed of 9 miles per hour. They can give a maximum tractive effort at starting of 256,000 lbs.

The air temperature in Bombay goes up to about 100 degs. F. in the shade, with a humidity of about 80 per cent. Owing to these climatic conditions, very special precautions had to be taken, and several special features incorporated to ensure that the batteries should be adequately protected against unduly high temperatures.

Each battery is rated at 400 ampere-hours

FIG. 1. DRIVER'S CABIN.

at the one-hour rate of discharge, which corresponds to about 750 ampere-hours at the 5-hour rate of discharge, and consists of 238 cells in series of the Kathanode type, manufactured by the D.P. Battery Company, the plates being assembled in ebonite containers. These containers have spacing pieces moulded on the outer surfaces to keep them apart, and they are so mounted in groups that every group has two sides exposed to the ventilating air. In order to ensure adequate insulation, the cells are mounted on battens 4 ins. clear of the floor, and the battens are supported on porcelain insulators.

covers, and to ensure easy operation of the latter special arrangements have been made. The cover is of the sliding type, but is pivoted in such a way that after it has been run out, it can be tipped so as to give complete access to all the cells. The cover is run out or back by means of a rack which is operated by a cranked handle from the side of the compartment. The whole of the mechanism is mounted in the space between the two walls of the compartment, and is thus clear of acid fumes. The arrangement of a compartment is seen in Fig. 3.

The itype iof controller used on the loco-

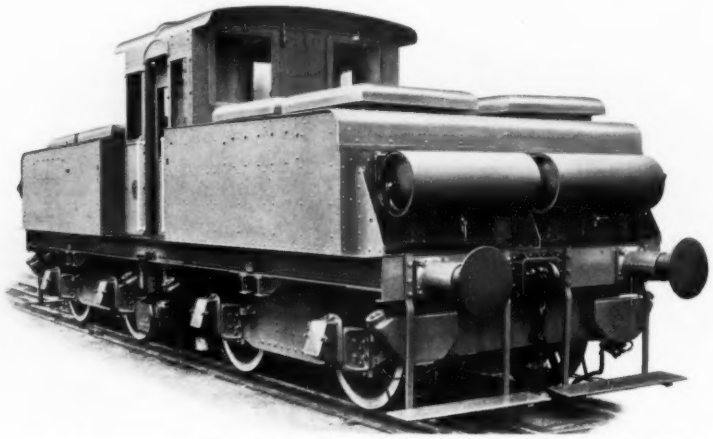


Fig. 2. One of the 50-ton, 440-volt, 240-H.P. Battery Locomotives.

The battery is mounted in halves in the two end compartments, which have louvres in the end walls and large ventilators in the cover. The cover and sides of these compartments are double, with large air spaces between, and the covers for the ventilation apertures are also double. By this means a free flow of air is ensured through, under and over the battery, and the double walls of the container and lid give considerable protection from the direct rays of the sun.

Of course, the construction described means increased weight, particularly in the removable

motives was designed specially in view of the large current to be handled, and is constructed on the well-known camshaft pridciple, but with hand operation. It consists of two camshafts arranged vertically and geared together, with the reverser drum, which is of the ordinary tramway type, mounted between them. In view of the large size of the controller, it has been found necessary to provide it with a hand-wheel instead of a crank handle. The controller is seen in the view of the cabin reproduced in Fig. 1. The controller gives 6 series, 5 parallel and 6 electric brake notches.

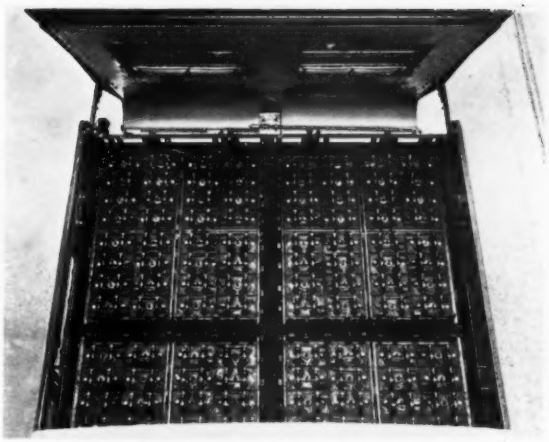


FIG. 3. BATTERY COMPARTMENT WITH COVER TIPPED FOR INSPECTION.

In addition, there is a notch at the end of the electric brake group which applies the air brake.

The locomotive is fitted with electric, hand and pneumatic brake apparatus. Electric braking has been installed as the normal method, in view of the importance of reducing to a minimum the demand on the battery for power to drive the compressor motor. As stated previously, the controller has six electric braking notches and one air brake notch, so that the greater part of the braking effort is produced by the traction motors acting as generators, while the air brake comes into operation only after the speed has been very much reduced, and is used almost solely for completing the braking operation or to hold the train at rest on a grade. There is, however, a separate emergency brake handle by means of which the air brake can be applied independently should the electric controller fail to operate. The air brake notch on the controller applies the brake by means of electro-pneumatic valves.

The central driving compartment is 6 ft. by 8 ft. 6 ins., and is provided with a double ventilated roof. The windows at each end are hinged, and drop windows are fitted to the doors. The apparatus in this cab is restricted to that necessary for driving and control, the compressor and resistances being mounted under the underframe between the bogies.

These locomotives are at present in course of shipment, and following the practice frequently adopted in the transport of steam locomotives, they are being shipped complete in every respect, except for the battery acid. The superstructures and bogies are stowed on board and handled from ship to dock side as one unit, so that on arrival, it will only be necessary to fill and charge the batteries and the locomotives will be ready for service.

An "English Electric" 100-ton Express Locomotive in service on the Imperial Government Railways of Japan. For various systems in that country Locomotives and Motor Coach Equipments totalling more than 200 have been ordered from this Company.

Diesel-Electric Traction.

One of the most important recent developments in railway traction work is the application of the Diesel engine for supplying the motive power in locomotives and motor coaches.

This application is in the form of a self-contained Diesel-electric unit in each motor coach or locomotive.

The use of the Diesel engine for traction purposes has been under experiment for some considerable time, and naturally in the first place a gear drive was considered. While engines up to 1,000 horse-power have been employed in this manner, the difficulties of providing a suitable change gear transmission have proved to be such that at the present moment electric transmission appears the more favourable method, and is being employed to a considerable and increasing extent.

It is a development which should be welcomed by all advocates of electric traction, as, properly considered, it does not in any way run counter to ordinary electrification. Self-propelled vehicles of this type should not affect the question of electrifying any lines on which complete electrification is commercially justifiable, for in appropriate cases electric track vehicles remain the most economical and efficient method of transport.

The Diesel-electric vehicle, however, has a very large field in those districts where the traffic density is not great enough to justify electrification, and it provides a motive power considerably cheaper than steam-propelled vehicles. Just as the development of a small high-powered petrol engine made aviation practicable, so the development of the high-speed Diesel engine rendered the application of this type of engine for traction purposes an engineering and commercial possibility.

Progress in the development of the high-speed Diesel engine is continually being made, and at the present moment these engines are being manufactured with an approximate total weight, including radiators, fuel tanks, etc., of 20 to 25 lbs. per horse-power. Of course, this figure varies according to the size of the unit, but it will be seen that the use of the engine in locomotives and motor coaches is a reasonable proposition.

The general principle of the Diesel-electric vehicle is essentially simple. The equipment consists of a Diesel engine driving a d.c. generator, which supplies current to the traction motors, which are of standard type.

So far mention has been made only of Diesel engines, but, of course, there is no difference in the electrical end whatever the means used for driving the electric generator. Engines using commercial petrol are equally adaptable, but in this case the fuel is much more expensive, and, generally speaking, petrol engines

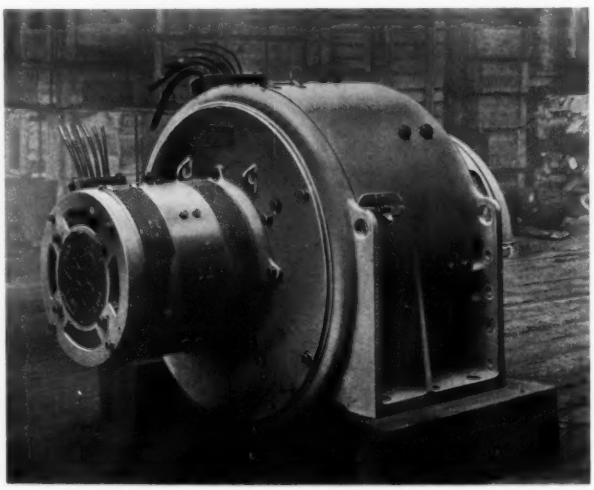


FIG. 1. GENERATOR AND EXCITER FOR 500 H.P. DIESEL-ELECTRIC UNIT.

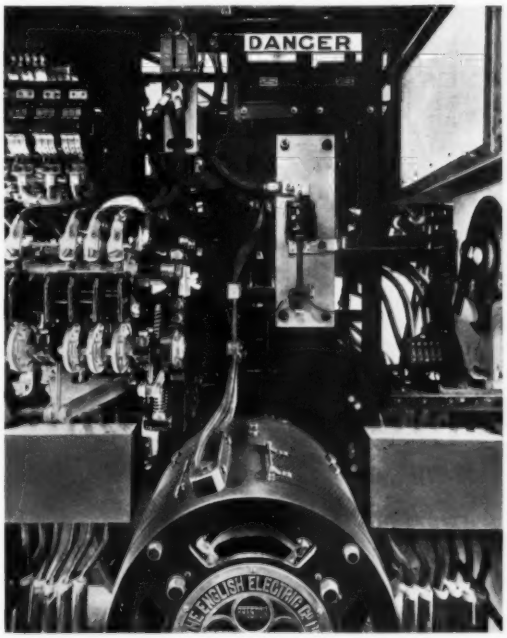


FIG. 2. CONTROL APPARATUS ON L M S TRAIN.

are used only in the smaller sizes.

In this connection it is worth recording that The English Electric Company has been one of the pioneers of this form of electric traction. Its Preston Works, when controlled by Dick, Kerr & Co., was amongst the earliest manufacturers of a petrol-electric coach, and later supplied a large number of petrol-electric locomotives which were used with considerable success during the War on light railway lines in France.

The problem to be dealt with in Diesel-electric traction is two-fold. In the first place, the power vehicle, whether it be a locomotive or a motor coach, resembles the steam engine, in that each vehicle is self-contained, and the output of its prime mover has a definite limit.

In the second place, the transmission of power, being electric, is inherently capable of high overloads for limited periods.

Owing to the enormous capacity of the power station in comparison with the rating of the rolling stock motor, ordinary electric rolling stock permits the characteristics of the electric motor to be utilised to the full. Therefore the aim of the designers of Diesel-electric equipments is to utilise the overload capacity of the electric portion without imposing overloads on the engine, and at the same time to make the maximum use of the prime mover. The problems presented in an endeavour to attain these features differ in locomotives and in motor-coaches. The motor-coach problem is in one sense the simpler of the two. Motor-coach service generally consists of operation on a definite route, with a load which varies only by a comparatively small percentage, corresponding to the weight of the passengers. The difference may be accentuated at times by the addition or withdrawal of a trailer coach, but it is possible to incorporate in the design of the electrical equipment features which will permit the power equipment to accommodate itself automatically to the required service.

The principle adopted in the " English Electric " equipment for motor-coaches is to supply the traction motors from a generator provided with two fields. One field is excited at approximately constant voltage from a direct-driven exciter, or, in certain circumstances, from a battery. The second field is a series field, acting in opposition to the shunt field.

Taking as an example a 200 H.P. equipment, Fig. 3 gives the characteristics of the generator, from which it will be noted that the reverse series field automatically limits the current which can be applied to the traction motors, even when starting from rest. Thus there is no possibility, by faulty manipulation on the part of the driver, of obtaining too great an acceleration or of spinning the wheels. It should also be noted that no starting resistance is required in the motor circuit. Further, the shape of the output curve of the generator is such that over a wide range of speed the

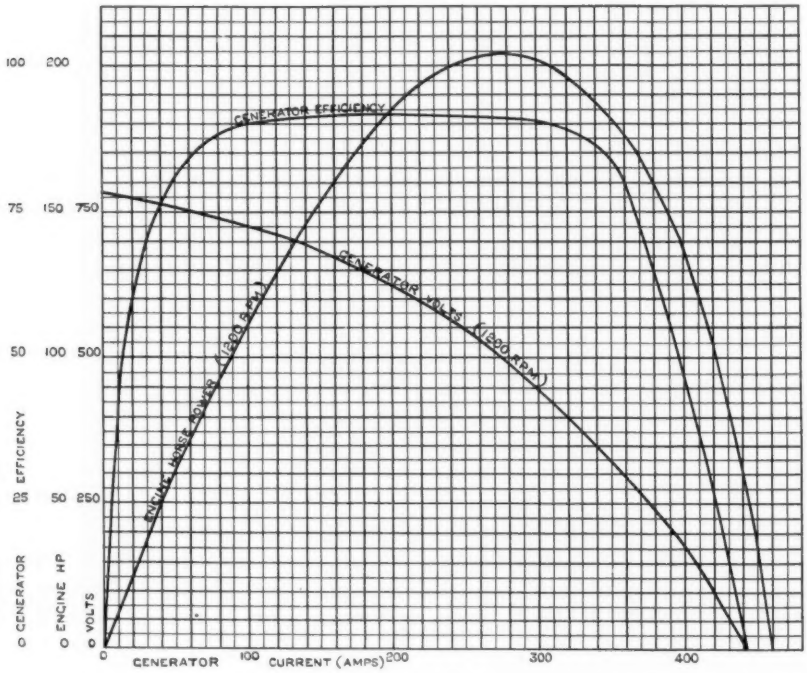


FIG. 3.
GENERATOR CHARACTERISTICS.

200 H.P. DIESEL-ELECTRIC MOTOR-COACH EQUIPMENT.

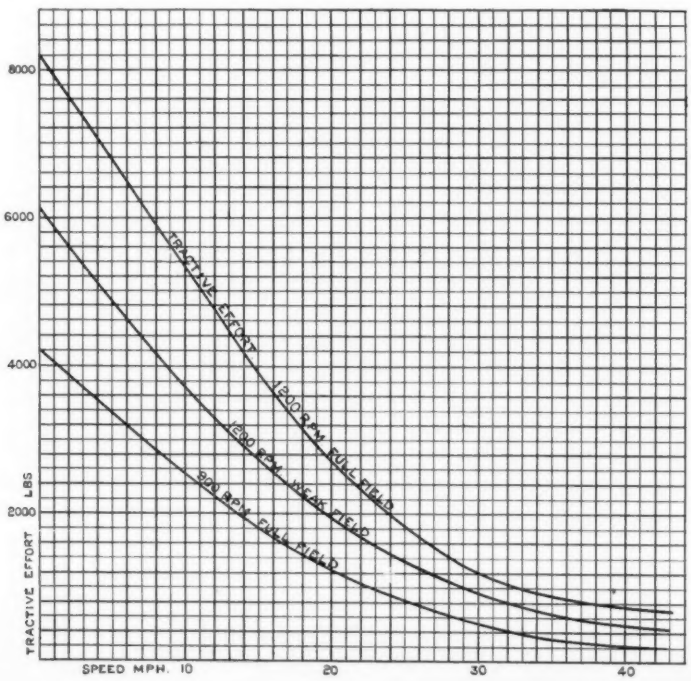


FIG. 4.
MOTOR-COACH
CHARACTERISTICS.

engine is being utilised at or near its maximum output, but at the same time the engine cannot be overloaded.

The control of the power given by the generator to the traction motors can be varied either by control of the engine speed or by control of the field of the generator. A combination of these two methods is found to provide the simplest and most economical method of control.

Referring again to the 200 H.P. equipment, with an engine having a full-load speed of 1,250 r.p.m. and an idling speed of 600 r.p.m., one intermediate running speed of 900 r.p.m. is provided, and the control is so arranged as to give three positions on the master controller, i.e., 900 r.p.m., 1,250 r.p.m. with a weak field, and 1,250 r.p.m. with a full field.

The characteristics of a motor coach equipped with this 200 H.P. engine are shown in Fig. 4.

The control of the engine speed is effected by solenoid operated valves working on the engine governor. The operation of these valves and the variation of the field strength on the generator are controlled through master controllers exactly similar in type to the master controllers provided on ordinary electric stock. There is thus no difficulty in arranging for multiple-unit operation of Diesel-electric coaches, each coach, of course, remaining a separate power unit in itself.

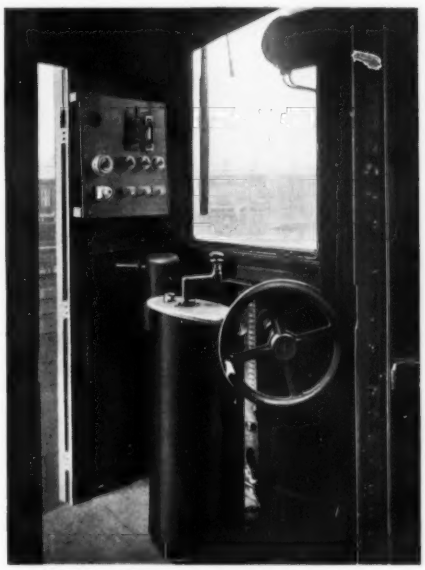


FIG. 5. DRIVER'S COMPARTMENT AND MASTER CONTROLLER.

A key diagram of the connections is shown in Fig. 6.

Another point in which motor-coach operation differs from locomotive operation is that in certain instances, particularly in cases of multiple-unit operation, it may be desirable that all the operations connected with starting up and shutting down the Diesel engine shall be controlled from any of the driver's compartments. This can be arranged for on the driving controller, so that the operator has only one control handle to manipulate. Two additional notches are provided on the master controller, and these are provided with interlocks, so that they are inoperative so long as the driver wishes to keep the engine running.

The master controller can, in addition, be provided with the usual dead-man's handle, the operation of which opens all the circuits, shuts down the engine and applies the brakes.

In developing their designs the Company's aim has been to provide an equipment which can be operated with no more difficulty than an ordinary electric train in which the driver need not concern himself with anything but the question of driving. It is absolutely foolproof, and neither the engine nor the electrical equipment can be overloaded.

At the present moment four orders are in hand for this class of vehicle. The first of these consists of an electric equipment for a 500 H.P. engine, ordered by Messrs. Wm. Beardmore & Co., the manufacturers of the engine, for installation on a coach of the London Midland & Scottish Railway.

In addition this Company is completing three 200 H.P. equipments for Messrs. W. Beardmore & Co., for service in Spain, and

these are being erected on coaches supplied by Messrs. Claytons Wagons, Ltd., Lincoln.

Orders have also been received for three Diesel-electric coaches for the Venezuela Central Railway, and a petrol-electric general service locomotive for the Montreal Harbour Commissioners.

500 H.P. EQUIPMENT.—The equipment for the London Midland & Scottish Railway is one which is being tried out by the railway company for the purpose of investigating the merits of Diesel-electric traction. The coach that has been equipped is a unit of the electric stock used on the Manchester-Bury line, and the conversion is being carried out by the engineering staff of the railway. The complete train is shown in the Frontispiece, together with a view of the Diesel-electric unit. The generator and exciter are shown separately in Fig. 1.

The power equipment consists of a 500 H.P. 8-cylinder Beardmore engine, coupled to a 340-kW., 600-volt generator and an 8-kW. exciter. The engine and generator are coupled together with one intermediate bearing and the frames are rigidly connected by a common bedplate. The exciter is of the overhung type at the generator end of the set.

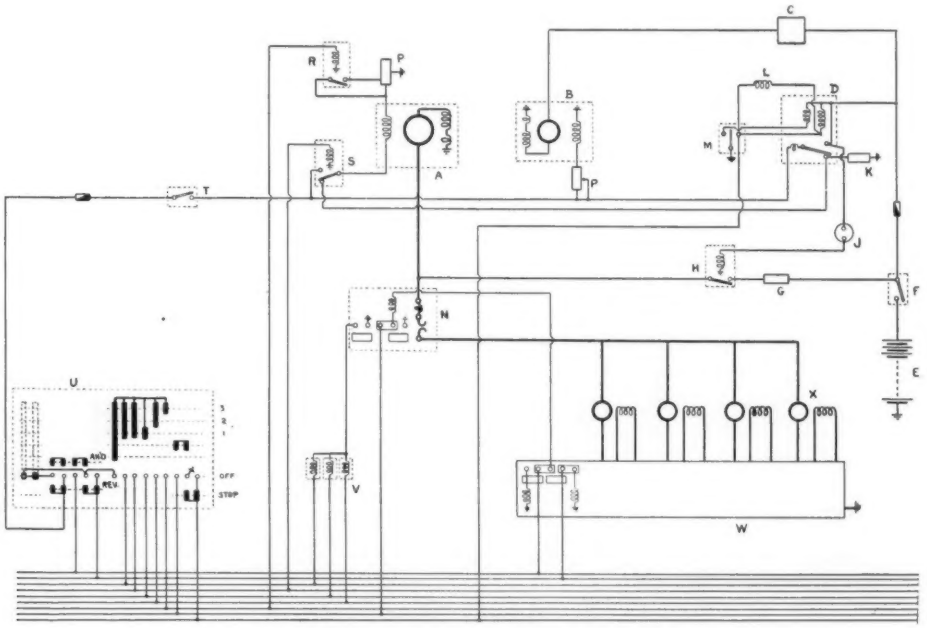


FIG. 6. DIAGRAM OF CONNECTIONS FOR DIESEL-ELECTRIC EQUIPMENT.

A. Generator; B. Exciter; C. Auto Cut-out Relay; D. Battery Relay; E. Battery; F. Battery Switch; G. Starting Resistance; H. Starting Contactor; J. Starting Switch; K. Field Discharge Resistance; L. Engine Stopping Solenoid; M. Trip and Set Switch; N. Line Breaker; P. Adjustable Resistances; R. Field Control Relay; S. Generator Field Breaking Contactor; T. Control Switch; U. Master Controller; V. Valve Solenoids; W. Reverser; X. Main Motors.

The engine has four speeds, an idling speed of 350 r.p.m., intermediate speeds of 600 and 750 r.p.m., and a full-load speed of 900 r.p.m. The generator supplies power to two traction motors, each of 280 H.P., mounted on one of the motor-coach bogies.

The control apparatus, illustrated in Fig. 2, is mounted on a self-contained frame-work fixed

over the generator.

The motor-coach is designed to operate, in normal service, with three trailer coaches. It is provided with a driving compartment at one end, and another driving compartment is provided on the third trailer at the other end of the train.

The control is entirely electrical, the driving apparatus consisting of a master controller, seen in Fig. 5, similar in general design to those used on electric stock, with the usual vacuum brake controls. The master controllers are provided with dead-man's handles.

A 120-volt battery of D.P. manufacture consisting of 60 cells is provided for starting the engine. When the battery is connected by means of a changeover switch to the generator, the latter acts as a motor, and rotates the set until the engine commences to fire. The battery is then disconnected from the generator. In addition to this the battery, under certain conditions, supplies the lighting and control current and the power for driving the exhauster motors. Normally these supplies are provided by the exciter, but as the exciter is driven by a variable-speed engine, arrangement had to be made to provide them from the battery when the exciter voltage drops below a predetermined limit. The battery is charged by the exciter during the periods when the exciter voltage is sufficiently high for the purpose.

To give a further range of speed than that provided by the various speeds of the engine, there are two additional notches on the master controller, which bring about weakening of the fields of the traction motors.

The 200 H.P. equipments for Spain and Venezuela are generally similar, and a description of the latter will suffice.

Each motor coach is 52 ft. long and will have a weight of about 33 tons without passengers or baggage. It is provided with a control compartment at each end, an engine compartment, a baggage compartment, and first and second class passenger compartments.

The coaches are being built at The English Electric Company's Preston Works. They are generally of wood construction on a steel underframe, but the engine compartment is built entirely of steel.

Owing to the heavy grades on the line the coaches are exceptionally well-equipped with brake gear. Compressed air brake gear of standard pattern applies brake blocks to one side of each wheel. A separate hand brake, applied from the driver's compartment, applies another brake block to each wheel, and in addition each truck is equipped with a Schlieren track brake, operated by compressed air. While this brake equipment is unusual it follows the lines of the brakes on the existing steam locomotives. The compressor motor is supplied from the exciter or battery according to which is in operation.

The traction equipment consists of four 50 H.P. standard traction motors connected in parallel, and driving on each axle through single-reduction spur gearing.

The engine is a six-cylinder Beardmore rated at 200 H.P. at 1,250 r.p.m., and is capable of temporary overloads up to 230 H.P. It has an idling speed of 600 r.p.m. and an intermediate speed of 900 r.p.m. It is coupled to a generator rated at 135 kW. at the maximum engine speed, and auxiliary services and excitation are supplied from an overhung exciter at the outboard end.

Starting is effected by using the generator as a motor and supplying it with current from a D.P. battery of 30 cells.

The general method of starting up and operation is the same as on the L.M.S.R. train.

Variation of speed and tractive effort is obtained by movement of a handle on the master controller, which, in addition to the idling and stopping positions for the engine, is provided with three running positions.

The problem of applying this means of propulsion to locomotives has several points differing from the above, and a description is deferred to a later issue of the Journal.

Electrification of Capetown Suburban Railways.

In Vol. III., No. 6 of this Journal, a description was given of the equipment supplied to the South African Railways & Harbours Administration for the electrification of the Capetown Suburban Lines. At that time manufacture was proceeding, but we were able to illustrate the description with pictures of apparatus and of the sample coach then being tested on the track at Preston Works.

We are now able to show views of the new electric stock in service at Capetown.

The equipments were all shipped by the early part of 1927, and erection was started at Capetown in the middle of April of that year. Erection of the equipments was carried out by The English Electric Company of South Africa, assisted by a technical staff from England, and the work was completed by February, 1928, so that the 215 coaches were turned out at the average rate of 22 per month.

Before being put into service each coach underwent an official test, and in October, 1927, the first section of the line, i.e., from Seapoint to Monument, a distance of 3½ miles, was put into operation with a 12-minute service.

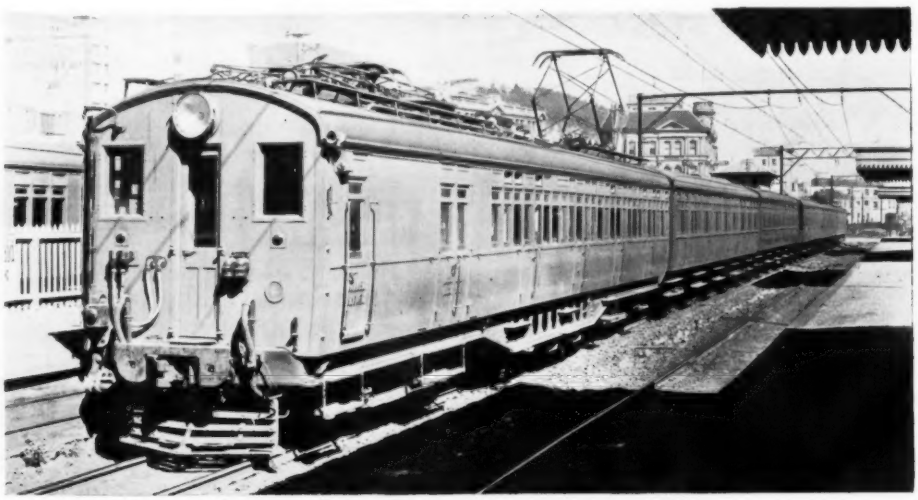
Electric service is expected to start on the next section of the line from Capetown to Retreat, a distance of 12 miles, during the present month, and the entire line from Capetown to Simonstown, a distance of 22½ miles, shortly afterwards. As each section is electrified, the electric stock entirely supplants the existing steam service.

The normal make-up of a train will be two motor coaches and four trailer coaches. During rush hours an additional unit consisting of one motor coach and one driving trailer coach will be added.

It may be as well to recapitulate briefly the general features of this contract.

The electrical equipments which were built at the Preston Works of the Company consist of 83 motor coach equipments, 37 driving trailer and 95 non-driving trailer coach equipments. Each motor-coach equipment comprises four 187 h.p. motors connected in pairs in series, and an " English Electric " camshaft control equipment.

The whole of the apparatus was built for operation on direct current at a normal line



A Six-coach Train on the Monument-Seapoint Route.

A Train in Monument Station. Table Mountain in the Background.

pressure of 1400 volts, the supply being 1500 volts at the substations.

In operation the trains are timed for an average speed of 20 miles per hour, and a maximum speed on the level of 50 miles per hour.

Each motor coach is equipped with two pantographs, normal operation being conducted with one pantograph up and one pantograph down. The pantographs are electro-pneumatically controlled. The train control equipment is housed in a compartment at one end of each motor coach, and is of the " English Electric " standard camshaft type, arranged for multiple-unit operation. The auxiliary machines and main resistances are mounted underneath the coaches.

Control and lighting is supplied from a 5½ kW. motor-generator set, which supplies current at 110 volts. The motor coaches are equipped with vacuum brakes, the vacuum being obtained from an electrically-driven rotary exhauster, the motor for which is supplied at line voltage.

The inauguration of the Capetown Suburban Electric Service marks a noteworthy step in the electrification of the suburban lines of the principal cities of the British Empire. Capetown now joins with Sydney, Melbourne and Bombay in adopting the modern means of transport. A point of interest is that of these four electrifications, only one derives its power from a hydro-electric station, and the conclusion may justly be drawn that the advantages resulting from electric traction justify its adoption whatever may be the source of electrical energy.

A Driver's Compartment.

THE PRODUCTS OF The English Electric Company

GENERATING PLANT for STEAM, WATER or OIL POWER

Complete Power Stations of any size. Steam Turbines & Turbo-alternators. Surface Condensers. Horizontal & Vertical Water Turbines & Alternators. Diesel & Fullagar Oil Engines. Alternators & D.C. Generators for all forms of drive.

ELECTRIC TRACTION

Complete Electric Traction Systems. Electric Locomotives. Electric Motor-coach stock. Diesel-electric stock. Motors & Control Equipment for Railway or Road Vehicles. Battery Locomotives. Industrial Locomotives for all services. Electric Tramcars. Electric Trolley Buses. Tramcar & Bus Bodies.

TRANSMISSION SYSTEMS at ANY VOLTAGE

Complete Indoor or Outdoor Switching Stations. Oil Circuit-Breakers of large rupturing capacity. Isolating Switches of all types. Transformers of any size, type or voltage. Booster Transformers. Induction Regulators. Instrument Transformers.

SUB-STATIONS & CONVERTING PLANT of ALL KINDS

E.H.T. & L.T. Switchgear. Complete Automatic Switching Equipments. Kiosk-type substations. Rotary Convertors. Motor Convertors. Motor-generators. Frequency Changers.

POWER EQUIPMENT for ALL INDUSTRIES

Specialists in the complete electrification of:— Iron and Steel Works. Non-ferrous Metal Works. Collieries. Quarries & Mines of every description. Brickyards. Cement Works. Sewage & Irrigation Works. Dockyards. Engineering Shops. Chemical Factories Dyeworks. Glass Works, Rubber Mills. Cotton, Wool, Silk & Jute Mills. Pulp & Paper Mills. Breweries. Sugar Factories. Food Factories.

A.C. & D.C. Motors & Control Gear in units from ¼ H.P. to 20 000 H.P. to meet all modern conditions of Starting Torque, Power Factor Correction, etc.

WORKS:

BRADFORD, COVENTRY, PRESTON, RUGBY, STAFFORD

HEAD OFFICE: QUEEN'S HOUSE, KINGSWAY, LONDON, W.C.2

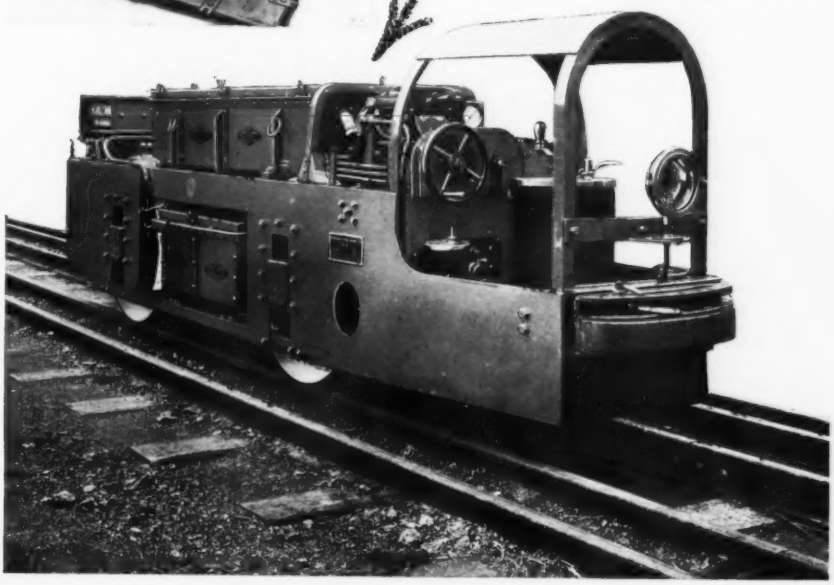
LOCOMOTIVE FOR THE POST OFFICE TUBE RAILWAY

—another example of English Electric engineering plus

D.P. KATHANODE BATTERIES

Booklet Free.

THE D.P. BATTERY CO., LTD.,
Bakewell - Derbyshire.
London : 11, Victoria St., S.W. 1.



S.D. 142

"English Electric"
CARTRIDGE FUSES

This type of construction readily lends itself to expansion.

Units can be built up to accommodate any number of ways for either single or three-phase systems.

E.H.T. FUSE CUBICLES

These fuse cubicles are designed for working pressures of 2,200, 3,300 and 6,600 volts.

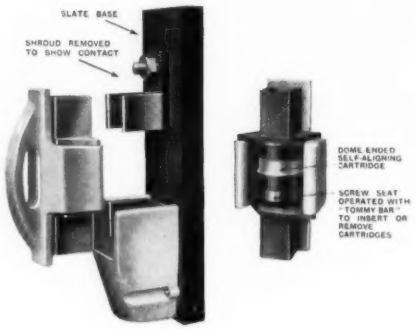
Maximum rating 400 kVA. per phase.

Guaranteed rupturing capacity of fuses 75,000 kVA. at 6,600 volts.

The fuse is mounted between isolating links and the doors are so interlocked that access to the fuse cannot be obtained until the isolating chamber doors have first been opened and reclosed.

This is necessary to meet the requirements of the Home Office Regulations and the whole unit has been submitted for approval to H.M. Electrical Inspector of Factories.

Write for Publication No. 975 which illustrates the many applications of these units.


SLATE BASE
SHROUD REMOVED TO SHOW CONTACT
DOME ENDED SELF-ALIGNING CARTRIDGE
SCREW SEAT OPERATED WITH "TOMMY BAR" TO INSERT OR REMOVE CARTRIDGES

L.T. HANDLE-TYPE CARTRIDGE SWITCH FUSE

Range 0–700 amperes.

Maximum Working Pressure 750 volts.

Guaranteed Rupturing Capacity 25,000 kVA.

Five sizes of handle are standardised to cover the whole working range.

A noteworthy feature is the dome-ended cartridge, making the bedding of the contact faces independent of the exact alignment of the adjacent parts.

Each unit complete with shrouds complies with the Home Office Regulations applicable to this type of apparatus.

The whole range is illustrated in detail complete with drilling dimensions, etc., in Publication No. 968.

ENGLISH ELECTRIC

THE ENGLISH ELECTRIC COMPANY LIMITED

Head Office:—

Queen's House, Kingsway, London, W.C.2.

Works: BRADFORD, COVENTRY, PRESTON, RUGBY AND STAFFORD.

Are YOU interested in PAINTS

For

MACHINE TOOLS or any kind of MACHINERY?

If so we commend to your notice

"STRATHCLYDE,"

ENAMEL FILLING

and

DULL STEEL-GREY PAINTS.

They are supplied in paste form and when thinned with Strathclyde Special Thinnings produce on any class of rough casting, the highest possible finish at the least possible expenditure of time and money. Samples and prices on request.

STRATHCLYDE PAINT CO., LD.,

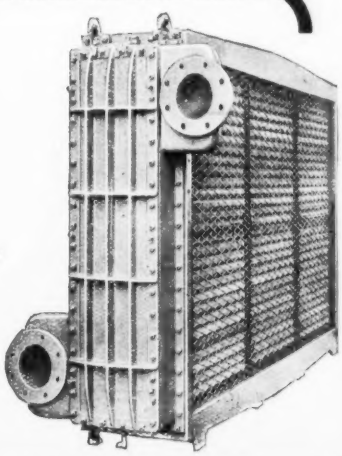
DALMARNOCK, GLASGOW.

Contractors to Home & Colonial Govts.; The Leading Railway Co.'s; Car & Wagon Builders, Engineers, etc.

Heenan

ENCLOSED CIRCUIT AIR COOLERS

For the Safe Ventilation of Turbo-Alternators



A plentiful and continuous supply of cool, clean, dry air is assured by means of this system of ventilation. All dirt and free moisture are excluded and risk of fire reduced to a minimum. Moreover, these Coolers are simple to operate, reliable in action, inexpensive and suitable for working in conjunction with any make of alternator on the market.

The following is a Small Selection of Names of Purchasers :—

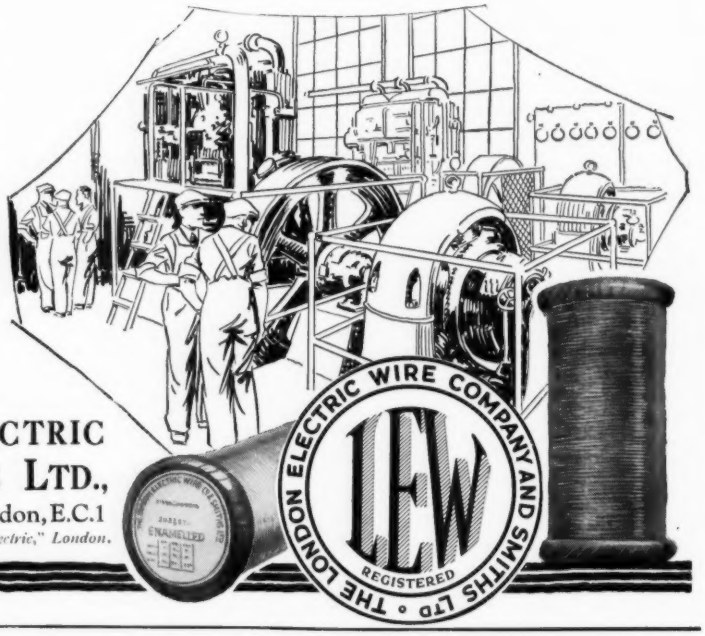
Aberdeen Corporation
British Admiralty
Barnsley Corporation
Bradford Corporation
Bedford Elec. Dept.
Brush Electrical Eng. Co. Ltd.
British Brown-Boveri Ltd.
British Thomson-Houston Co. Ltd.
Consett Iron & Steel Co. Ltd.
English Electric Co. Ltd.
Edinburgh Corporation
Formby Depot (L.M.S. Rly.)
General Electric Co. Ltd.
Glasgow Corporation
James Howden & Co. Ltd.
Hull Corporation
London Power Co. (Bow Road Stn.)
London Power Co. (Deptford Stn.)
Leicester Corporation
Lancs. Dynamo & Motor Co., Ltd.
Marylebone Corporatn.
Metropolitan-Vickers Electrical Co., Ltd.
Newport (Mon.) Corp.
Ocker Hill Gen'ratg. Stn.
Oerlikon Ltd.
Peterboro' Corporation
Preston Corporation
Powell Duffryn S.C. Co. Ltd.
S. Wales Power Co. Ltd.
Stepney, Met. Borough
Stockport Corporation
St. Pancras Boro' Coun.
Woolwich Corporation
Worcester Corporation
Yorks Elec. Power Co.
Auckland Pow. Stn., N.Z.
Adelaide Tramways
Athens, St. George's Power Stn.
Centrale de Droogen-bosch (Brussels)
Capetown Suburb'n Rly.
Eastern Bengal Rlys.
Perak Power Station
State Coal Mines (Holland)
Etc., Etc.

PLEASE SEND FOR OUR LITERATURE.

Heenan & Froude Ltd—Worcester—England

Don't risk a breakdown!

To buy cotton, silk or enamel insulated wire on price is "penny wise, pound foolish." By eliminating all risk of costly breakdowns, LEW wire is the cheapest in the long run. The LEW mark has set the highest standard for quality for over 50 years.



The London Electric Wire Co. & Smiths Ltd.,
Playhouse Yard, Golden Lane, London, E.C.1
Phone Clerkenwell 1388. *"Electric," London.*

Ball-Jointed Insulators

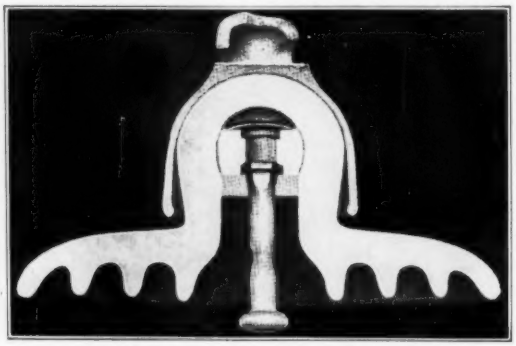
Made by the largest manufacturers of Insulators in the World.

Pin Type Insulators.

Suspension and Strain Insulators.

Shackle Insulators.

Dry Press Porcelain of Every Description.



Section through Ball-Jointed Insulator after mechanical test. The pull, 18,700 lbs., exceeds the elastic limit of the metal pin, yet the porcelain remains whole.

Telephone & Telegraph Insulators.

High Tension Insulators for pressures up to 200,000 volts.

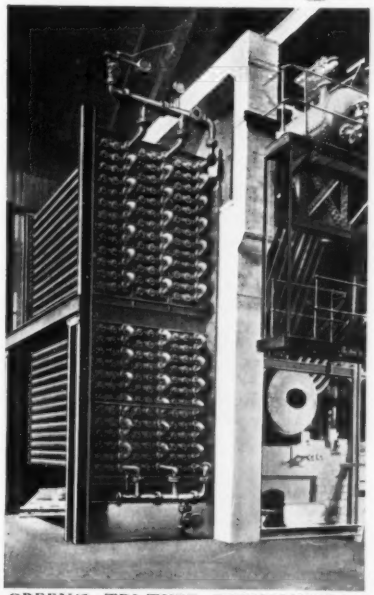
May we quote for your next requirements of Insulators of any type?

The Equipment & Engineering Co.,
2-3, Norfolk Street, Strand,
LONDON, W.C. 2.

Telegrams: "Kharparts, Estrand London."

Telephone: City 1088 (2 lines).

"What is aught but as 'tis valued?"



GREEN'S TRI-TUBE ECONOMISERS

The value attached by steam-users to

GREEN'S ECONOMISER

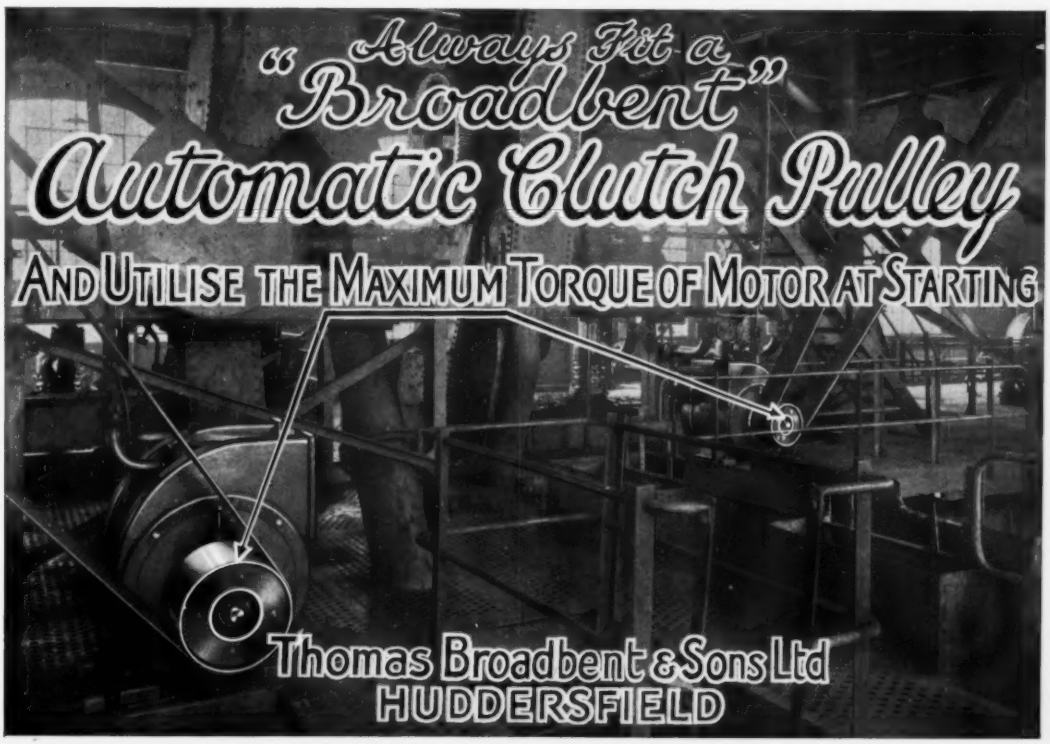
is typified in the following extract from a letter written during a recent coal strike:

"It is almost impossible for us to carry on without it, on account of the poor coals we are receiving"

Green's Economiser increases by 15-20 per cent. the calorific value of coal in steam plants

Recommendations and estimates free on receipt of details of the boiler plant it is to serve

E. GREEN & SON, LTD., WAKEFIELD *Telegrams & Cables: "Economiser."*



CONSULT US FOR

ROLLING MILLS—(HEAVY, MEDIUM AND LIGHT)

OF THE MOST MODERN CONSTRUCTION.

The designs of "DAVY" Mills are based on the latest practice, both in Great Britain and abroad, and ensure:

High output.
Economy in production.
Freedom from breakdown.

WE ARE MAKERS OF:

BLOOMING MILLS. REVERSING PLATE MILLS. THREE-HIGH PLATE MILLS. SECTION MILLS. MERCHANT MILLS. SHEET MILLS.

"MORGAN" CONTINUOUS ROLLING MILL PLANTS. TYRE AND WHEEL MILLS. COLD ROLLING MILLS.

ACCESSORY MACHINERY INCLUDING SHEARS, HOT SAWS, MANIPULATORS, ROLLER GEAR, INGOT TILTERS, ROLL LATHES, etc.

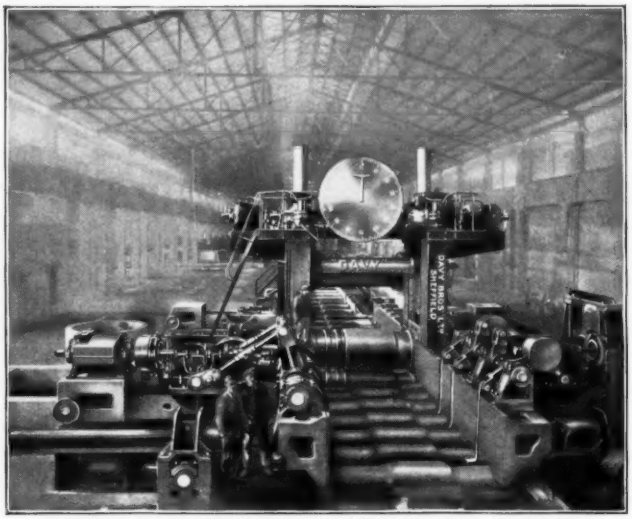
FORGING PRESSES AND HYDRAULIC MACHINERY. STEAM HAMMERS. STEAM BOILERS.

DAVY BROTHERS

LIMITED.

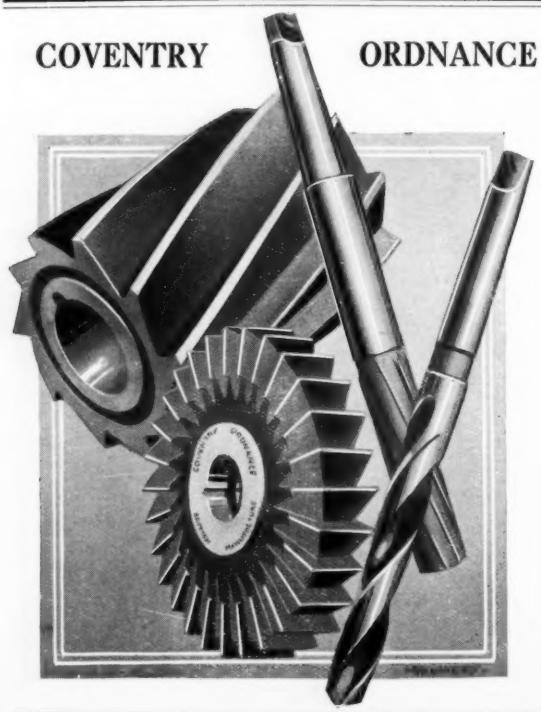
SHEFFIELD

ESTABLISHED 1830.



BLOOMING AND SLABBING MILL WITH ROLLS 40 in. DIAMETER.

COVENTRY ORDNANCE



High Speed Tools.

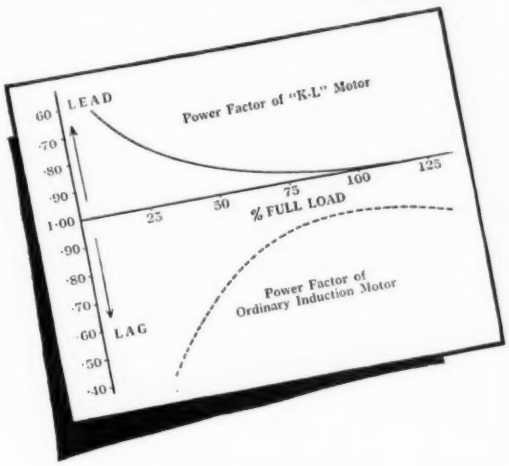
Twist Drills.
Milling Cutters.
Reamers.
Broaches.
Taps & Dies.
Boring Bars.
New Simplex Pneumatic Riveting Hammers & Drilling Machines.

Manufacturers:

The
ENGLISH ELECTRIC
Company Limited.

ORDNANCE WORKS, COVENTRY

KOSFI-LEADING
Compensated Induction
MOTORS



PROFIT BY IMPROVING YOUR POWER FACTOR

In this Compensated Induction Motor the good starting properties, large overload capacity and simple operation of a slipring induction motor are combined with the valuable characteristic of Power Factor Correction.

By installing a "Kosfi-leading" Motor, the Power Factor of your load may be increased and your Power Bill reduced. High Power Factor means the better utilisation of Generating Plant and Mains.

WRITE FOR PUBLICATION
No. 900

The
ENGLISH ELECTRIC
Company Limited.

WORKS:— BRADFORD, COVENTRY, PRESTON, RUGBY, STAFFORD.
HEAD OFFICE:—
Queen's House, Kingsway, London, W.C.2.

INDEX TO ADVERTISERS

Alfa-Laval Co., Ltd. III
Associated British Machine Tool Makers, Ltd. VI
Attwater & Sons IV
Beardmore, William & Co., Ltd. VII
Broadbent, Thos. & Sons, Ltd. XIII
Cox-Walker & Partners IV
Craske, Alfred, Ltd.... III
Davy Brothers Ltd. XIV
D. P. Battery Co., Ltd. IX
English Electric Company, Limited X, XIV, XV
Equipment & Engineering Co. XII
Green, E. & Son, Ltd. XIII
Heenan & Froude Ltd. XI
London Electric Wire Co. & Smiths Ltd. XII
Mason, E. N., & Sons, Ltd..... II
Renold, Hans, Ltd. V
Ruths Steam Accumulators, Ltd. V
Siemens Brothers & Co., Ltd. VIII
Straker Brothers, Ltd. XVI
Strathclyde Paint Co., Ltd. XI
Yorkshire Copper Works, Ltd. I

All communications respecting Editorial Contents and Advertising Rates should be addressed to The Editor, The English Electric Journal, Queen's House, Kingsway, W.C.2.

When communicating with Advertisers please mention English Electric Journal.

Telegrams:
"STRAKER, LONDON"

Telephone:
BISHOPSGATE, 2444
(4 lines)

"Ye Olde Bishops Gate"
1620

The Bishopsgate Press

PRINTERS AND STATIONERS
TO THE ELECTRICAL INDUSTRIES
PUBLISHERS, LITHOGRAPHERS
& ACCOUNT BOOK MAKERS.

STRAKER BROTHERS, LIMITED.
ESTABLISHED 1800.

194-200 Bishopsgate, London, E.C.2.

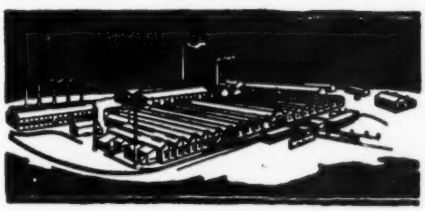
Please mark all enquiries E/I.

"Yorkshire" TUBES in Copper, Brass and Cupro-Nickel, for Power Stations.

CUPRO-NICKEL CONDENSER TUBES (80/20, 70/30, etc.) AND OTHER ALLOYS.

BRASS CONDENSER TUBES in all standard and special mixtures including 70/29/1 (Admiralty), 70/30 and "Bemal."

COPPER TUBES up to 24 in. diameter.



The Prevention of Corrosion-Erosion.

Research in our Laboratories has made it quite clear that this type of trouble is due to entangled air and gases in the cooling water.

We can advise you how to obviate or get rid of this trouble; in the meantime "Yorkshire" Tubes are the best palliative, and where trouble is severe

"Yorkshire"

Cupro-Nickel Tubes

are more economical than brass.

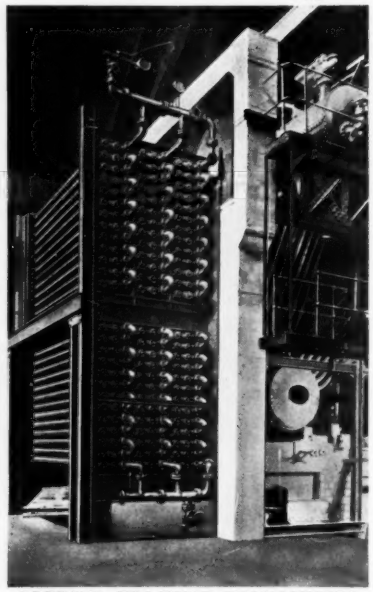
Our Research Department has 20 years' experience of Tube problems and will be pleased to investigate any Tube troubles, and suggest the remedy.

YORKSHIRE
Nothing but Tubes
COPPER WORKS LTD

LEEDS, ENGLAND.
Telephones: 20031. *Telegrams*: "*Tubes, Leeds.*"
LONDON OFFICE: 53, New Broad Street, E.C.2

Contractors to British and Foreign Admiralties and all Government Departments.

"What is aught but as 'tis valued?"



GREEN'S TRI-TUBE ECONOMISERS

The value attached by steam-users to

GREEN'S ECONOMISER

is typified in the following extract from a letter written during a recent coal strike:

"It is almost impossible for us to carry on without it, on account of the poor coals we are receiving"

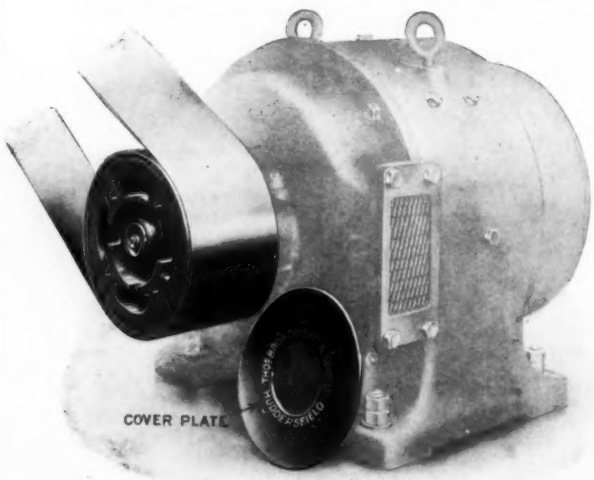
Green's Economiser increases by 15-20 per cent. the calorific value of coal in steam plants

Recommendations and estimates free on receipt of details of the boiler plant it is to serve

E. GREEN & SON, LTD., WAKEFIELD *Telegrams & Cables: "Economiser."*

"Broadbent" PATENT AUTOMATIC CENTRIFUGAL CLUTCHES

Should always be fitted to Electric Motors.



A "Broadbent" Automatic Clutch Pulley for Belt Drive.

ADVANTAGES:

Enable Motor to start up easily against Full Load.

Entirely dispense with Fast and Loose Pulleys.

Safe Protection for Motor against Overload.

Cheap Motors and Star-delta Starters can be used.

Considerably Reduce Starting Current Consumption.

Enlarged New Catalogue on Request.

Thomas Broadbent & Sons, Ltd.,
ENGINEERS,
HUDDERSFIELD.

E. N. MASON & SONS LIMITED

THE MANUFACTURING DRAWING OFFICE STATIONERS

VISIT OUR STAND No. 127 (GALLERY)

AT THE

MACHINE TOOL AND ENGINEERING EXHIBITION

OLYMPIA

SEPTEMBER 5TH—22ND 1928

ENGINEERS' AND ARCHITECTS'

COMPLETE PHOTO PRINT ROOM EQUIPMENT

"ARCLIGHT"

HORIZONTAL ELECTRIC PHOTO COPIERS.

CONTINUOUS GAS AND ELECTRIC DRYING AND IRONING MACHINES

ALSO THE NEW

"ARCLIGHT" HORIZONTAL CONTINUOUS ELECTRIC PHOTO COPIERS

ALL THESE MACHINES WILL BE AVAILABLE FOR PRACTICAL DEMONSTRATIONS

IN THE MEANTIME WE SHALL BE PLEASED TO SEND YOU OUR CATALOGUE — SECTION 13 — "PRINT ROOM EQUIPMENT."

ARCLIGHT WORKS, COLCHESTER, ENGLAND.

LONDON — BIRMINGHAM — MANCHESTER — NEWCASTLE-ON-TYNE.

RICHARDS
RAPID PRODUCTION
VERTICAL BORING
TURNING MILL

THERE IS STRENGTH IN EVERY PART

"RICHARDS" RAPID PRODUCTION VERTICAL BORING AND TURNING MILL.

Study the massiveness of this Frame

Centralised Control; Automatic lubrication and many other refinements combine to produce an essentially modern machine.

ASSOCD. BRITISH MACHINE TOOL MAKERS LIMTD. TRADE MARK

May we send you full particulars?

Associated British Machine Tool Makers, Ltd.,
17, Grosvenor Gardens, London, S.W. 1.

When Better Machine Tools are built, A.B.M.T.M. will be the Builders.

INVEST IN PERMANENT ECONOMIES!

ADDITIONAL to low first cost many permanent economies are effected by Renold Chain Drives.

No power is wasted but full power is transmitted without slip or friction. High efficiency is maintained throughout long life with negligible maintenance costs.

Compactness allows considerable economies in space and light. Costly stoppages due to transmission failures are eliminated.

Time is saved by purchasing complete drives from stock with the aid of the Renold Standard Drive Booklet.

HIGH OR LOW SPEEDS.	RATIOS 6 : 1 TO 1 : 1	LONG OR SHORT CENTRES.

STOCKS AT ALL RENOLD BRANCHES

RENOLD STANDARD STOCK DRIVES

DELIVERED READY FOR INSTALLING IN LESS TIME THAN IT TAKES TO QUOTE ON OTHER TRANSMISSION GEAR.

POWER USERS
Send for Free Booklet.

HANS RENOLD LIMITED
DIDSBURY, MANCHESTER.

PHOTOGRAPHY AS A SALES MEDIUM

is daily becoming a greater necessity. When buildings, plant, equipment and manufactures need illustrating, there is no form so direct and appealing as photographs.

The foremost engineers, shipbuilders, architects and contractors employ the Stewart Bale photographic service in all parts of the Kingdom for permanent records of work done and as an aid in securing new orders.

STEWART BALE'S photographs need the minimum of artist's retouching before blocks are made, thus saving expense and securing more natural-looking results.

The STEWART BALE photographic Service and Experience is at your command. An opportunity of submitting examples of current work, discussing and advising is welcomed.

STEWART BALE

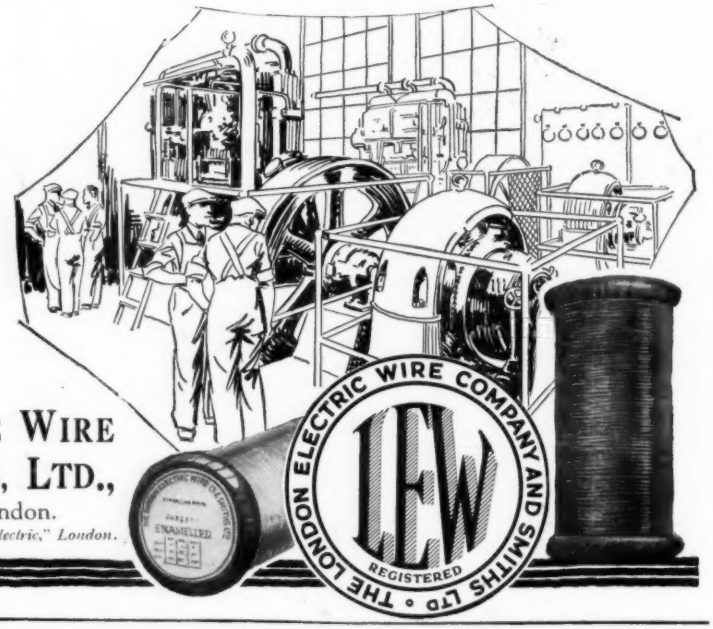
Engineering & Technical PHOTOGRAPHER

53 LORD STREET. LIVERPOOL

Telephone - - - - - 4014 Bank
Telegrams - "Lenses, Liverpool"

Don't risk a breakdown!

To buy cotton, silk or enamel insulated wire on price is "penny wise, pound foolish." By eliminating all risk of costly breakdowns, LEW wire is the cheapest in the long run. The LEW mark has set the highest standard for quality for over 50 years.



The LONDON ELECTRIC WIRE COMPANY & SMITHS, LTD.,
Church Road, Leyton, London.
Phone Walthamstow 2531. *"Electric," London.*

BALL-JOINTED INSULATORS

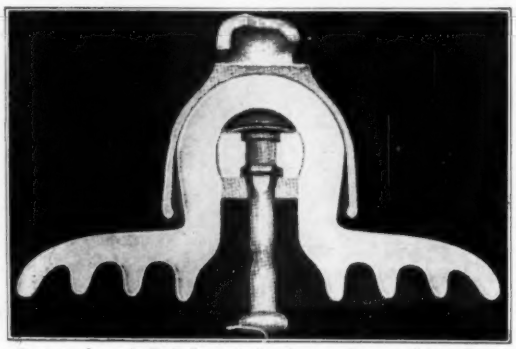
Made by the largest manufacturers of Insulators in the World.

PIN TYPE INSULATORS.

SUSPENSION AND STRAIN INSULATORS.

SHACKLE INSULATORS.

DRY PRESS PORCELAIN OF EVERY DESCRIPTION



Section through Ball-Jointed Insulator after mechanical test. The pull, 18,700 lbs., exceeds the elastic limit of the metal pin, yet the porcelain remains whole.

TELEPHONE & TELEGRAPH INSULATORS.

HIGH TENSION INSULATORS for pressures up to 200,000 volts.

May we quote for your next requirements of Insulators of any type?

Telegrams: "Kharparts, Estrand London."

The Equipment & Engineering Co., Ltd.,
2-3, Norfolk Street, Strand,
LONDON, W.C. 2.

Telephone: City 1088 (2 lines).

MARELLI ELECTRIC FANS

A.C. SINGLE-PHASE CEILING FANS

Maestrale - Maestralino - Maestralino Junr. - Condor - Airone.

A.C. THREE-PHASE CEILING FANS

Aliseo - Aliseino

Imitation has been the sincerest form of flattery since we were

FIRST ON THE MARKET IN 1908.

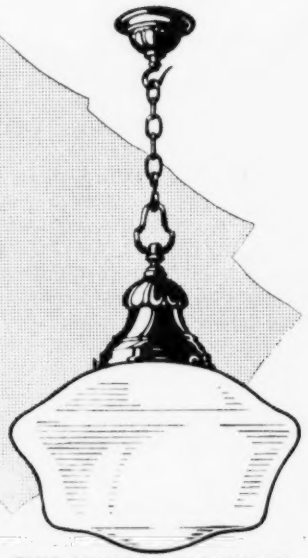
OUR LATEST MODELS EMBODY ALL THE IMPROVEMENTS MADE AS A RESULT OF AN EXTENSIVE EXPERIENCE IN THE TROPICAL MARKET.

MARELLI & CO., LTD.,

FAN HOUSE, GARLICK HILL,

LONDON, E.C. 4.

Lighting Units of Distinction



THIS SILVARAY GLASSWARE FITTING IS A VERY EFFICIENT COMMERCIAL LIGHTING UNIT WRITE US FOR LIST Nº 156

Insist on

SIEMENS
ELECTRIC LAMPS
for every lighting purpose
OBTAINABLE FROM ALL ELECTRICAL DEALERS

Adv^t of SIEMENS ELECTRIC LAMPS AND SUPPLIES LIMITED, 38/9, Upper Thames Street, London, E.C.4.